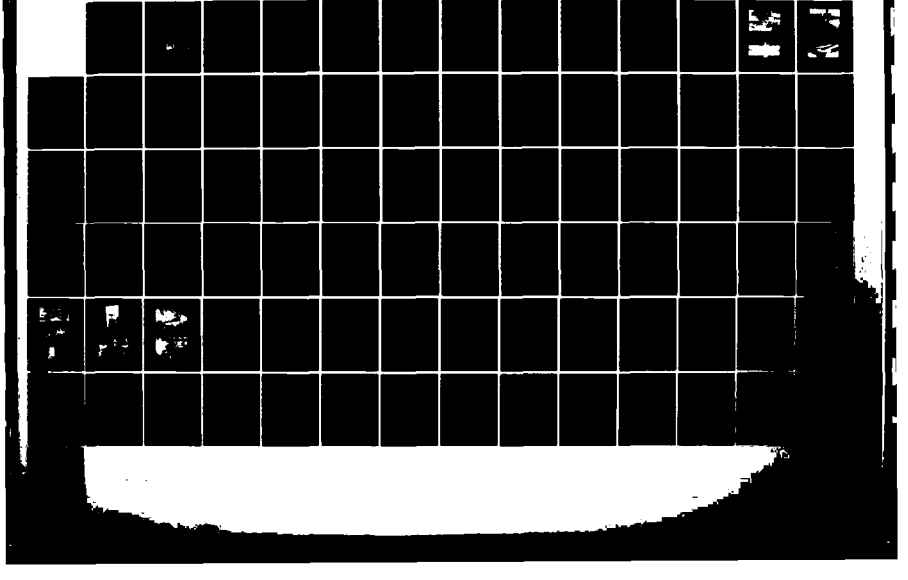
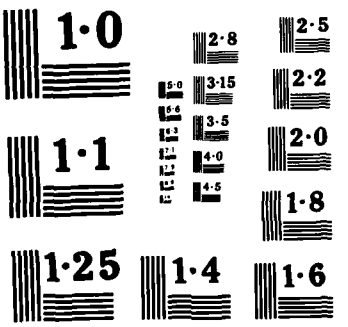
AD-A156 482 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 1/1
PLEASANT LAKE DAM (NH.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV NOV 78
UNCLASSIFIED F/G 13/13 NL





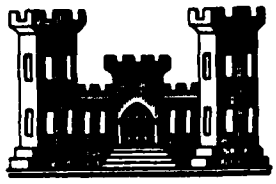
MERRIMACK RIVER BASIN
NEW LONDON, NEW HAMPSHIRE

PLEASANT LAKE DAM

NH 00362

NHWRB 176.02

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

NOVEMBER 1978

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NH 00362	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Pleasant Lake Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE November 1978 13. NUMBER OF PAGES 65
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
New London, New Hampshire
Tributary of Blaxkwater River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a 404 ft. long, earth filled rock crib which incorporates a 58 ft. long spillway and a 42 inch diameter steel pipe outlet controlled by a stop-log weir. It is intermediate in size with a significant hazard potential. The dam is in poor condition at the present time. The dam requires considerable maintentance.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

PLEASANT LAKE DAM
NH 00362

MERRIMACK RIVER BASIN
NEW LONDON, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification No.:	NH 00362
NHWRB No.:	176.02
Name of Dam:	PLEASANT LAKE DAM
Town:	New London
County and State:	Merrimack, New Hampshire
Stream:	Tributary of Blackwater River
Date of Inspection:	September 20, 1978

BRIEF ASSESSMENT

The Pleasant Lake Dam is a 404 foot long, earth-filled rock crib which incorporates a 58 foot long spillway and a 42 inch diameter steel pipe outlet controlled by a stoplog weir. The structure, which has a maximum height of 12 feet, is owned by the Town of New London. While a dam of some type has existed at this site since 1835, alterations in the early 1900's probably brought the structure to its present configuration.

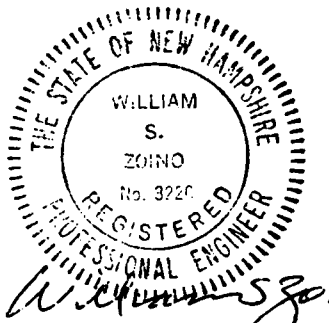
The dam, which lies on a tributary of the Blackwater River, is used primarily to control the level of Pleasant Lake for recreational use. The drainage area of the structure consists of 11.4 square miles of steeply sloping, heavily forested terrain. The dam's maximum impoundment of 3000 acre-feet places it in the INTERMEDIATE size category, while the anticipated property damage, but unlikely loss of life, in the event of a failure results in a SIGNIFICANT hazard potential classification.

Based on the size and hazard potential classification and in accordance with the Corps' guidelines, the Test Flood (TF) is between one half the Probable Maximum Flood (PMF) and the full PMF. The selected TF inflow of 16,000 cfs results in a discharge at the dam of 12,460 cfs. Since the maximum capacity of the dam prior to overtopping is only approximately 640 cfs, the TF would overtop the dam by over 4 feet.

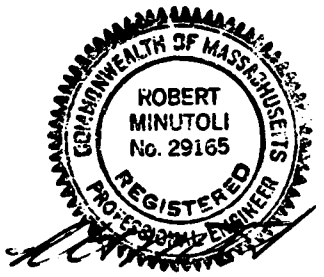
The dam is in POOR condition at the present time, due primarily to several large voids in the embankment in the vicinity of the gate house, evidence of erosion through the earthfill and historical indications of serious seepage problems. Additionally, the dam requires considerable routine maintenance.

Included in the recommended maintenance procedures are provision of additional freeboard, repair of potholes and voids, brush clearing and tree trimming and removal, seepage monitoring, minor concrete repairs, removal of the redundant sluice gate, installation of a gage and institution of a formal warning system.

The above recommendations and remedial measures should be implemented within one year of receipt of the Phase I Inspection Report by the owner. Based on the dam's POOR condition, periodic technical inspections should be scheduled annually.



William S. Zoino
New Hampshire Registration 3226



Robert Minutoli
Massachusetts Registration 29165

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the Test Flood should not be interpreted as necessarily posing a highly inadequate condition. The Test Flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

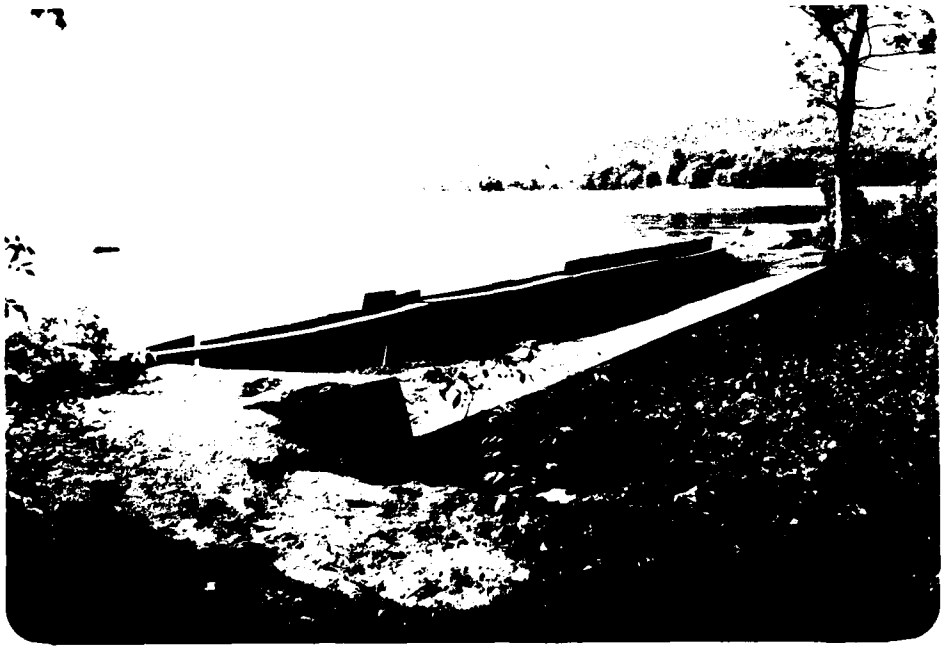
TABLE OF CONTENTS

Table of Contents - cont.

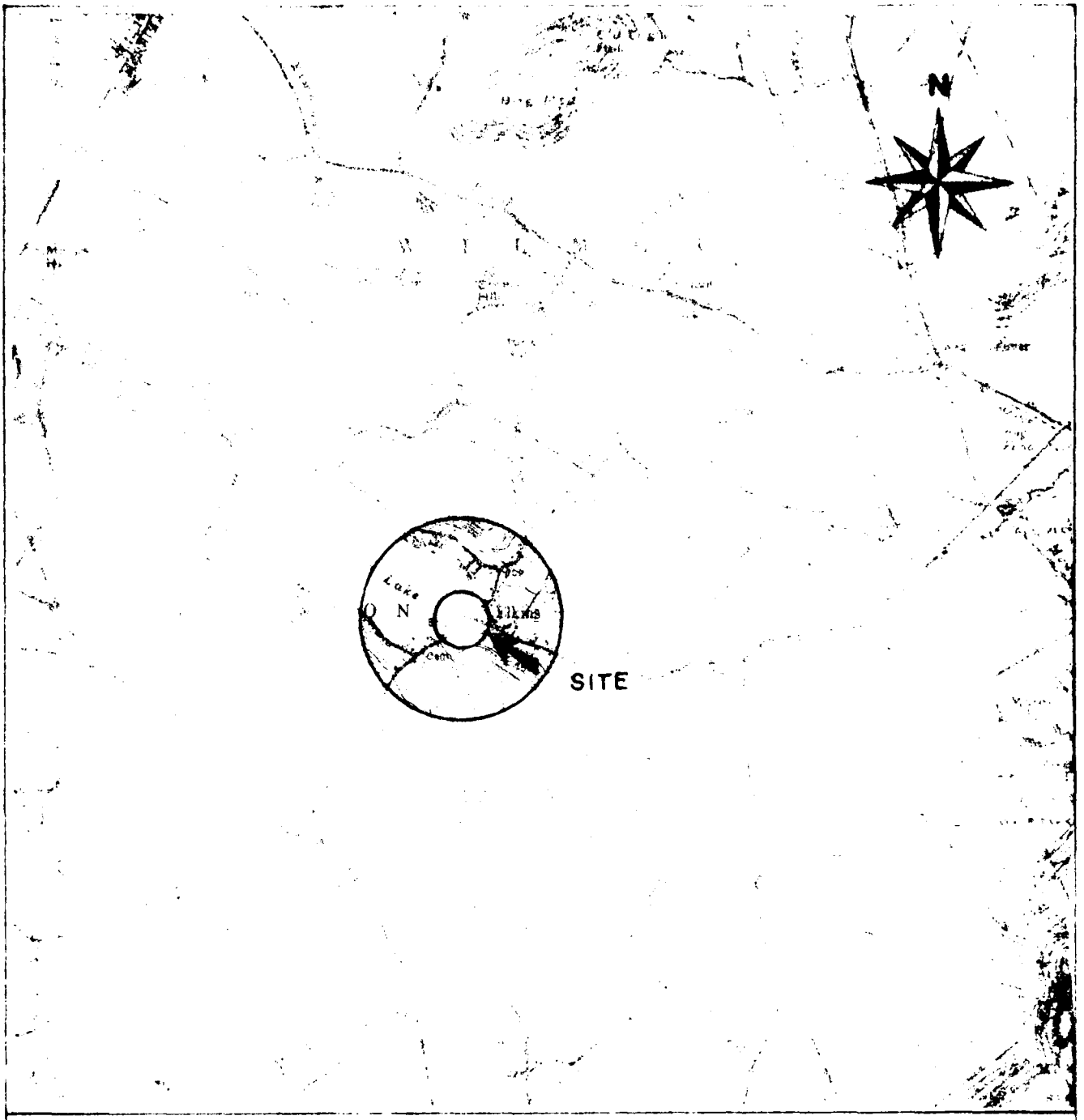
Overview from left side upstream

Overview from downstream channel showing outlet and gate house

Overview of spillway from left side



Overview of spillway from right side



- SCALE -

0 1/2 1 2 miles

FROM USGS MT. KEARSAGE, N.H.
QUADRANGLE MAP

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC, INC.
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCUS PLAN

FILE No. 2067

PLEASANT LAKE DAM NEW HAMPSHIRE

SCALE	AS NOTED
DATE	SEPT 1978

PHASE I INSPECTION REPORT
PLEASANT LAKE DAM
SECTION 1
PROJECT INFORMATION

1.2 General

(a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD) has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to GZD under a letter of August 22, 1978 from Col. Ralph T. Garver, Corps of Engineers. Contract No. DACW 33-78-C-0303 has been assigned by the Corps of Engineers for this work.

(b) Purpose

(1) Perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

(3) Update, verify and complete the National Inventory of Dams.

(c) Scope

The program provides for the inspection of non-federal dams in the high hazard potential category based upon location of the dams and those dams in the significant hazard potential category believed to represent an immediate danger based on condition of the dam.

1.2 Description of Project

(a) Location

The Pleasant Lake Dam lies on a tributary of the Blackwater River in the village of Elkins, New Hampshire, which is located on Route 11. The portion of the USGS Mt. Kearsarge, NH quadrangle presented on page ix shows this locus. Figure 1 of Appendix B is a site plan prepared from the map and the site visit.

(b) Description of Dam and Appurtenances

This dam is a 404 foot long, earth-filled rock crib which incorporates two control features (Figure 2). Approximately 210 feet of the rock crib is faced with concrete on the upstream side. The structure has a maximum height of approximately 12 feet.

The dam's two control features are a 58 foot long, free overfall spillway and a 42 inch diameter steel pipe (Figure 3). The spillway consists of a concrete cap over rubble stone masonry with a trashrack on the upstream side. Discharges through the steel pipe are controlled by a stoplog weir located just upstream of the pipe inlet. A concrete-filled sluice gate is also used by the owner, although the stoplog weir, constructed on the recommendation of the New Hampshire Water Resources Board (NHWRB) in 1974, was intended to and does render the gate functionally useless. It was the Board's intent that use of the gate be abandoned upon construction of the weir, as the gate had created problems in controlling the lake level for some time. Despite the Board's recommendations, the gate is still operated, although it serves no useful purpose.

(c) Size Classification

The dam's maximum impoundment of 3000 acre-feet falls within the 1000 to 50,000 acre-feet range which defines INTERMEDIATE size category as defined in the "Recommended Guidelines."

(d) Hazard Potential Classification

While the village of Elkins lies immediately below the dam, the majority of development in the area is built high enough to be out of the area affected by a dam failure. While property damage would be extensive, loss of life is not anticipated. For these reasons, a SIGNIFICANT hazard potential classification is warranted.

(e) Ownership

In 1975, ownership of the dam passed from the Elkins Fish and Game Club, which controlled the dam for recreational purposes, to the Town of New London. Mr. Robert McMichael, Box 87, Elkins, NH 03233, a selectman in the Town of New London, has unofficially become the responsible town official for the dam as he lives in Elkins. His phone number is (603) 526-6165. Historical records indicate that the Public Service Company of New Hampshire (PSCNH) owned the dam as recently as 1939. The date of transfer from the PSCNH to the Elkins Fish and Game club could not be determined.

(f) Operator

Mr. McMichael operates the dam.

(g) Purpose of Dam

The primary purpose of the dam is to maintain Pleasant Lake for recreational use. Some ancillary flood control benefits are also derived.

(h) Design and Construction History

Contact with knowledgeable local residents indicates that the first dam at this site was a timber structure built around 1835. Little is known about the alterations which occurred over the years to get the dam into its present configuration. It is known that the Boston firm of Barrows and Breed developed plans incorporating the dam into the Blackwater River Power Development Project in 1910. The upstream face of the dam has been faced with concrete in three stages beginning approximately 10 years ago. The most recent work was accomplished in 1974 at the suggestion of the NHWRB and included additional facing and construction of the stoplog weir.

(i) Normal Operational Procedure

The lake is maintained at or near El. 805 during the summer recreational months by maintaining up to four feet of stoplogs in the weir. In late fall, all stoplogs are removed and the gate, which should really never be closed, is opened to draw the lake down to the minimum level that will still protect submerged pipes from freezing. Every third year, the lake remains drawn down into early summer to permit lake shore repairs.

1.3 Pertinent Data

(a) Drainage Area

Pleasant Lake receives runoff from 11.4 square miles of steeply sloping, heavily forested terrain. Great Brook, Little Brook and several smaller streams carry runoff into the impoundment. There is considerable development around the shores of the lake.

(b) Discharge at Damsite

(1) Outlet Works

The dam's only outlet is the 42 inch diameter steel pipe which is controlled by stoplogs inserted just upstream of the pipe. The stoplogs functionally replaced the steel sluice gate, although it remains in place and is operated in conjunction with the placement and removal of stoplogs.

(2) Maximum Known Flood at Damsite

No official records of the historic lake levels or discharges are available for this dam. Contact with residents, however, indicates the maximum known flood accompanied the hurricane of 1938 and resulted in the dam being overtopped by two feet. This lake level indicates a discharge of approximately 4500 cfs. This flood flow further resulted in the washing out of the road bridge 200 feet downstream and the old mill dam 300 feet further downstream. While no storm of similar magnitude has been experienced since, water levels have reached the top of the dam on several occasions.

(3) Spillway capacity at maximum pool elevation:

500 cfs at El. 807

(4) Gated pipe capacity at normal pool elevation:

130 cfs at El. 805

(5) Gated pipe capacity at maximum pool elevation:

140 cfs at El. 807

(6) Total discharge capacity at maximum pool elevation:

640 cfs at El. 807

(c) Elevation (feet above MSL)

(1) Top of dam: 807 ±

(2) Maximum pool: 807 ±

(3) Recreational pool: 805 ±

(4) Spillway crest: 805

(5) Streambed at centerline of dam: 796.3 ±

(6) Maximum tailwater: Unknown

(d) Reservoir

(1) Length of recreational pool: 1.7 miles ±

(2) Storage - recreational pool: 1850 acre-feet ±
- maximum pool: 3000 acre-feet ±

(3) Surface area - recreational pool: 575 acres ±

(e) Dam

(1) Type: Earth filled rock crib

(2) Length: 404 feet

(3) Height: 12 feet ±

(4) Top Width: 17 feet ±

(5) Side slopes - U/S Vertical
- D/S Vertical

(6) Zoning, impervious core, cutoff and grout curtain: Unknown

(f) Spillway

(1) Type: Concrete capped rubble stone masonry

(2) Length of weir: 58 feet

(3) Crest elevation: 805 feet ±

(4) U/S channel: Broad approach from lake

(5) D/S channel: Narrow with heavy vegetation

(g) Regulating outlets

As mentioned previously, the dam's only regulating outlet is the 42 inch diameter steel pipe. Discharge through the pipe is controlled by the stoplog weir immediately upstream of the pipe. While the concrete-filled steel sluice gate is still in place and while its operating mechanism is still well maintained, it serves no purpose since construction of the stoplog weir recommended by the NHWRB. The invert of the 42 inch diameter pipe is at El. 796.3.

SECTION 2 - ENGINEERING DATA

2.1 Engineering Records

The design of this dam is quite simple and incorporates no unusual features. No original design drawings or calculations are available.

2.2 Construction Records

No construction plans or records of any value are available for the structure. The crude sketches included in the historical data provide little useful information.

2.3 Operational Records

The owner operates the dam in a manner consistent with its intended purpose and engineering features.

2.4 Evaluation of Data

(a) Availability

The lack of any useful data concerning the dam's proper dimensions, the construction of its embankment or foundation conditions at the site warrants an unsatisfactory evaluation for availability.

(b) Adequacy

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is thus based primarily on the visual inspection, past performance and sound engineering judgement.

(c) Validity

Since the observations of the inspection team generally confirm the information contained in the sparse historical data, a marginal evaluation for validity is assigned.

SECTION 3 - VISUAL OBSERVATIONS

3.1 Findings

(a) General

The Pleasant Lake Dam is in POOR condition. Several prompt repairs and considerable routine maintenance are required to arrest further deterioration of the structure. The repairs recommended by the NHWRB in 1974 have been implemented to a minor degree, not "over the next few years... in an orderly manner" (Page B-9) as anticipated by the Board.

(b) Dam

(1) Embankments (Photos 1, 2 and 3)

The dam's embankment is a continuous, 404 foot long earth-filled rock crib. No useful information concerning the internal construction of the earth fill is available. A 1974 letter (Page B-9) by the NHWRB indicates that leakage through the dam has been a problem in the past.

While inspection of the earth-filled crib revealed no evidence of horizontal or vertical movement, the elevation of the top of the dam varies by as much as a foot owing to erosion of the surface. Mr. George McDonald, who accompanied Mr. McMichael during the inspection, indicated that waves often wash over the top of the dam during the spring, a situation which would certainly contribute to the erosion observed. The NHWRB recognized this same problem in 1974 when they recommended that the dam's upstream concrete facing be raised two feet higher than it is at the present time (Page B-8). The present freeboard averages 2 feet, which is less than the minimum 3.2 feet recommended by the American Society of Civil Engineers (ASCE) for a fetch of approximately 2 miles.

Several other observations cast some doubt as to the adequacy and integrity of the crib. During a preliminary visit on May 31, 1978, a pothole was observed in the surface between the gate house and the spillway.

At the time of the formal inspection on September 20, 1978, this hole had been repaired, but a new hole was noted to the right of the gate house. The hole was approximately 12 inches in diameter and at least 3 feet deep. While inspecting the downstream face of the dam immediately above the outlet pipe, voids 5 to 10 feet into the earth-filled crib were observed through the rubble stone masonry (Photo 3). The presence of a considerable amount of small debris in this area indicates that water reaching the top of the dam via rain and waves may be creating potholes in the top of the embankment and exiting through the downstream rubble masonry.

There is considerable brush growing all along the earth fill. Additionally, several trees growing in the dam near the spillway and the abutments require attention.

There is no evidence of displacement of the crib walls or cracking of the retained fill. Available plans show no indication of any foundation drainage features.

During the May preliminary visit, a seepage of less than 10 gpm was observed at the toe of the downstream wall approximately 54 feet left of the gate house. The seepage was clear and showed no evidence of soil particle movement. Neither this nor any other seepages were observed on September 20, probably because the lake level had dropped at least 4 feet since May. The water level in September was less than 4 feet above the toe of the crib.

The dam's concrete facing is generally in good condition. There is a vertical crack approximately 80 feet to the right of the gate house and a horizontal void 2 inches by 6 inches in diameter approximately 30 feet to the left of the gate house. Minor spalling is evident at several locations.

(2) Outlet Works (Photos 4 and 5)

The right side of the concrete inlet structure suffers from considerable erosion. Reinforcing steel is exposed at this location. The trashracks protecting the inlet structure are in good condition.

There is a 6 inch by 9 inch void between the right side of the sluice gate structure and the concrete wall. Continuous flow through this void generates turbulence which will cause further concrete deterioration. As mentioned previously, this gate is no longer an integral part of the outlet works, although its mechanical operating system has been maintained in excellent condition. The gate was operated without difficulty during the inspection.

As mentioned previously, there are significant voids between the outlet pipe and the walls of the old timber lined sluiceway from the original dam. These voids facilitate continuous soil erosion from the potholes in the top of the dam. The concrete headwall around the outlet end of the pipe is seriously deteriorated with approximately 10 square feet of voids and exposed reinforcing steel.

The wood frame gate house is in good condition.

(3) Spillway (Overview Photos)

With the exception of minor, fine random cracking and isolated minor spalling, the spillway structure, including its abutments with the earth fill, is in good condition.

(c) Appurtenant Structures

The dam has no appurtenant structures.

(d) Reservoir

An examination of the shoreline revealed no evidence of movement or other instability. Observation of the surrounding area showed no evidence of work in progress or recently completed which might increase the flow of sediment into the lake. Additionally, there were no changes to the nature of the watershed observed which might adversely affect the runoff characteristics of the basin. There is considerable development all around the lake.

(e) Downstream Channel (Photos 6, 7 and 8)

Given the dam's limited operational capability, there are no downstream conditions which pose a hazard to the safety of the structure. The road bridge 200 feet downstream of the dam would attenuate any flood wave in reaches further downstream. The old mill dam 300 feet further downstream is in deteriorated condition and could be washed out in a flood. It presents, however, no additional hazard. There is considerable vegetation growing in the channel between the dam and the road bridge and several trees growing in and around the channel which could become obstructions in a storm.

3.2 Evaluation

The Pleasant Lake Dam is rated in POOR condition based upon the uncertain condition of the earth-filled rock crib. In general, the dam's major components are sufficiently accessible to permit a satisfactory visual inspection.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

As mentioned previously, the town maintains the lake level at El. 805 ± during the summer recreational period. In late fall, the level is lowered to the minimum that will still prevent submerged pipes from freezing. Every third year the drawdown continues into early summer to permit shore repairs and improvements.

4.2 Maintenance of Dam

No formal maintenance program exists for the dam. At the insistence of the NHWRB, some repairs were carried out in 1974 by the previous owner, the Elkins Fish and Game Club. The dam's present condition suggests that a vigorous preventative maintenance program is necessary.

4.3 Maintenance of Operating Facilities

The deterioration of the steel sluice gate led to the NHWRB recommending that it be removed after construction of the stoplog weir. The present weir requires little maintenance. While the sluice gate serves no further purpose, its mechanical operating system was rebuilt 5 years ago and is very well maintained.

4.4 Description of Any Warning System in Effect

No formal warning system exists for the dam.

4.5 Evaluation

The dam's present POOR condition is a direct result of a lack of routine maintenance and an increased effort in this area is indicated. Additionally, the dam's condition and the lake's occasional high levels warrant implementation of a formal warning system during anticipated flood periods.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features

(a) Available Data

Data sources available for Pleasant Lake Dam include several prior inventory and inspection reports, the New Hampshire Water Control Commission's "Data on Dams in New Hampshire" dated April 1939 and "Data on Reservoirs and Ponds in New Hampshire" dated June 1939 and various letters of correspondence concerning the dam.

A rough sketch dated in 1939 depicts the configuration of the original dam. The spillway and gate flow capacities of this dam are calculated on several sheets dated 1969. Another rough sketch dated July 1974 depicts some repairs carried out as a result of a 1974 NHWRB inspection.

(b) Experience Data

Subparagraph 1.3(b) (2) presents historical data for this dam.

(c) Visual Observations

Pleasant Lake Dam is an earth and rubble stone masonry structure near the center of Elkins, New Hampshire. The dam has an overall crest length of about 404 feet at an elevation that varies from two to three feet above the normal lake level as defined by the height of the dam spillway. The dam has a maximum height of about twelve feet above the channel and a top width varying from approximately 15 to 20 feet.

The discharge features consist of two structures separated by about 170 feet. The regulating outlet is a 42 inch diameter steel pipe through the base of the dam that is controlled by a stoplog weir located just ahead of a gate. The gate is in good condition, but has substantial leakage in the closed position. The spillway structure is a 58 foot long weir consisting of an inclined concrete slab on rubble stone masonry. The elevation of the spillway crest as taken from the normal lake level shown on the USGS topographic map is 805.0 feet above Mean Sea Level (MSL).

The invert elevation of the steel outlet pipe on this basis is about 796.3 feet. At the time of the inspection, the water level in the lake was about five feet below the spillway crest or at about elevation 800.

Just downstream of the dam is a constricted channel section created by a highway embankment with a roadway level at about the same level as the spillway. The stream at this location passes through a 13 foot by 8.5 foot box culvert. Beyond this point, two other dams on the stream within the first quarter-mile below Pleasant Lake Dam create small impoundments. The stream in this region is paralleled by a main business and residential roadway through the Town of Elkins, with several homes and businesses within the possible flood hazard area.

(d) Overtopping Potential

The hydrologic conditions of interest in this Phase I investigation are those required to assess the dam's overtopping potential and its ability to safely allow an appropriately large flood to pass. This analysis requires use of the storage and discharge characteristics for the structure to evaluate the impact of an appropriately sized Test Flood.

Guidelines for establishing a recommended Test Flood based on the size and hazard potential classifications of a dam are specified in the "Recommended Guidelines" of the Corps of Engineers. As specified in these guidelines, the appropriate Test Flood for a dam classified as INTERMEDIATE in size and SIGNIFICANT in hazard potential would be between one-half of the Probable Maximum Flood (PMF) and the full PMF.

The chart of "Maximum Probable Peak Flow Rates" obtained from the Corps of Engineers, New England Division is used to define the applicable PMF. For Pleasant Lake Dam, which has a drainage area of 11.35 square miles and a "rolling" topography, the chart gives a PMF flow of 1600 cfs per square mile. This runoff results in a total PMF flow of 18,200 cfs and a one-half PMF flow of 9100 cfs.

The "Recommended Guidelines" suggest that if a range of values is indicated for the Test Flood, the magnitude most closely related to the involved risk should be selected.

Since the risk may be considered on the higher side of the SIGNIFICANT hazard category, a Test Flood of 16,000 cfs is used as a Test Flood inflow for Pleasant Lake.

Applying the procedure suggested by the Corps of Engineers, New England Division for "Estimating the Effect of Surcharge Storage on Maximum Probable Discharges" produces a Test Flood, corrected for storage, of 12,025 cfs. This amount represents a twenty-five percent reduction, indicating that the lake has a significant damping effect on the magnitude of the peak flow. The Storage-Stage Curve used to determine the surcharge storage for these calculations is developed assuming that the surcharge storage available is equal to the lake area times the depth of surcharge. This assumption ignores any spreading or increase of area with depth.

The Stage-Discharge Curve is developed by defining discharge as the sum of the flows through the gate, over the spillway, over the dam crest and over the side slopes at the ends of the dam. These calculations are based on the spillway acting as a sharp crested weir at elevation 805 and the 42 inch outlet pipe assumed to be fully open with an invert 8.7 feet below the spillway. The dam crest, which acts as a broad-crested weir two feet higher than the spillway, has an effective length of 351 feet. The overbanks at the ends of the dam are assumed to act as broad-crested weirs with lengths varying as a function of the water level.

Application of the corrected peak Test Flood discharge of 12,460 cfs to the derived Stage-Discharge relationship results in a maximum stage at the dam of 6.1 feet above the spillway crest, or 4.1 feet above the top of the dam.

5.2 Hydrologic/Hydraulic Evaluation

The results of the hydrologic and hydraulic calculations indicate that the outlet capacity of Pleasant Lake Dam is insufficient to pass the applicable Test Flood of 16,000 cfs without significant overtopping of the dam. Flow over the crest of the dam is not desirable since most of this portion of the dam is an unstabilized earthen embankment and is not intended to carry flow.

The limited freeboard of only two feet above the spillway represents a significant hazard for a lake having these flow characteristics. It is estimated that the maximum capacity of the outlet works with the lake level at the dam crest would be only 640 cfs. From this fact it is evident that extensive additional outlet capacity, possibly in the form of a larger and/or lower spillway, would be required to even approach the recommended Test Flood flow.

5.3 Downstream Dam Failure Hazard Estimates

The flood hazards in downstream areas resulting from a failure of Pleasant Lake Dam are estimated using the procedure suggested in the COE New England Division's April 1978 "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs." This procedure accounts for the attenuation of dam failure hydrographs in computing flows and flooding depths for downstream reaches.

For the purposes of these calculations, failure is assumed to occur as soon as the dam is overtopped at a lake elevation of 807.0 feet. This level corresponds to a height of 10.7 feet above the streambed. The breach width is assumed to be 70 feet. The resulting dam failure discharge is then estimated as 4100 cfs.

The stream below Pleasant Lake Dam passes through a developed portion of the village of Elkins with a number of buildings, bridges, and mill ponds along its route. For the purposes of this study, this developed area is segmented into four reaches. Below these reaches there is little development adjacent to the stream, so the flood hazard is considered insignificant.

Reach 1 covers an area only 200 feet long which is bounded upstream by Pleasant Lake Dam and downstream by the road culvert. No attenuation due to storage would occur in this small reach, although the peak outflow from this reach would be limited somewhat by the roadway embankment and bridge opening. To calculate this capacity it is assumed that the water depth upstream of the culvert is equal to the 10.7 foot depth of water when the dam failed. With this depth, the flow through the culvert opening is estimated using FHWA nomagraphs. Flow over the roadway embankment is computed using the equation for flow over a broad-crested weir. The resultant total flow passed on to Reach 2 is reduced to about 2000 cfs as a result of this constriction.

Reach 2 covers the region between the highway bridge and an old mill dam located about 300 feet downstream. It is assumed that no further attenuation of the flow would occur in this reach and that the depths of flooding would be determined by the discharge capacity of the mill dam. On this basis, it is calculated that a depth of flow of about 5.8 feet above the spillway of the dam (3.8 feet above the dam crest) would be required to pass the 2000 cfs of flow. Since the first floor of the store adjacent to the dam is only about 2 feet above the dam crest, a certain amount of structural damage to this building and possibly to several other buildings in this area would be expected. The potential for loss of life associated with these shallow depths of flooding is considered remote.

Reach 3 parallels a major business and residential street in the village of Elkins. An estimated 8 to 10 structures are located between this road and the stream channel, with first floor elevations about 8 feet above the stream bottom. Flooding depths along this reach are controlled by the stream channel characteristics in the steep upper portion of the reach and by the discharge characteristics of a second old mill dam in the lower portion. Again, assuming no further attenuation of the flood flow, it is calculated that a flow depth of 7.0 feet would develop along the confined stream section and that a flow depth of 4.3 feet over the dam spillway would develop. Although some minor structural damage would be expected to some of the buildings, the potential for loss of life is again considered minimal.

A fourth reach extending another 200 feet below the second mill dam has a steeply sloping, but narrow, channel with high banks. There are no buildings along this reach, but a highway culvert at its lower end could be washed out. Below this point, the stream widens and is relatively flat through a large marshy area that would greatly attenuate the remaining flow. Nothing located downstream of the highway culvert would be affected by failure of Pleasant Lake Dam as described above.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

(a) Visual Observations

The field investigation revealed no significant displacements or distress which warrant the preparation of structural stability calculations based on assumed sectional properties and engineering factors. The large voids on either side of the outlet pipe are, however, of significant concern and could threaten the long-term integrity of the dam.

(b) Design and Construction Data

The minimal data available would be of little use to a stability analysis were one deemed necessary.

(c) Operating Records

There are no formal operating records for this dam. Thus, no information concerning the stability of the dam during periods of high flow is available.

(d) Post-Construction Changes

Available information concerning the precise nature of the post construction changes to the dam is insufficient to assess the effects of such changes on the structure's stability.

(e) Seismic Stability

The dam is located in Seismic Zone No. 2 and, in accordance with recommended Phase I guidelines, does not warrant seismic analyses.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

(a) Condition

The Pleasant Lake Dam is in POOR condition at the present time.

(b) Adequacy of Information

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance and sound engineering judgement.

(c) Urgency

The recommendations and improvements contained herein should be implemented by the owner within one year of receipt of this Phase I Report.

(d) Need for Additional Investigations

Additional investigations should be performed by the owner as outlined in Paragraph 7.2 below.

7.2 Recommendations

It is recommended that the owner retain a qualified geotechnical engineer to conduct a detailed investigation of the present internal condition of the earth-filled crib.

It is also recommended that further hydrologic and hydraulic studies be made to determine the spillway adequacy.

7.3 Remedial Measures

Pleasant Lake Dam requires considerable operating and maintenance type repairs to insure its long-term use and safety. Included in these repairs are the following:

(1) Increase the freeboard of the dam under normal spring time lake levels to meet current ASCE standards.

(2) Repair any potholes or other voids in the top of the dam.

(3) Fill the void between the original sluiceway and the outlet pipe and completely seal the downstream headwall.

(4) Remove all brush and trees growing in the dam's earthfill sections.

(5) Monitor the seepage noted 54 feet to the left of the gate house, paying particular attention tc changes in quantity or turbidity. If necessary, institute repairs to preclude damage from the seepage.

(6) Repair the void in the upstream concrete facing 30 feet to the left of the gate house.

(7) Repair eroded concrete surfaces in the inlet structure.

(8) Remove the sluice gate as recommended by the NHWRB or permanently fix it in the open position.

(9) Clear all vegetation from the downstream channel between the dam and the road bridge and trim or remove all trees overhanging the channel.

(10) Institute a program to observe the dam during anticipated flood periods and to warn downstream residents in the event of an emergency.

(11) Install a gage at the dam and institute a formal procedure for recording lake levels and dam operations.

(12) Perform technical inspections of the dam every year.

7.4 Alternatives

Alternatives to the measures listed below include breaching of the dam or construction of a new dam engineered to present standards.

APPENDIX A

VISUAL INSPECTION CHECKLIST

INSPECTION TEAM ORGANIZATION

Date: September 20, 1978

NH 00362
PLEASANT LAKE DAM
New London, New Hampshire
Tributary of Blackwater River
NHWRB 196.02

Weather: Sunny and warm

INSPECTION TEAM

Robert Minutoli	Goldberg, Zoino, Dunnicliff & Associates, INC. (GZD)	Team Captain
William S. Zoino	GZD	Soils
Nicholas Campagna	*GZD*	Soils
Andrew Christo	Andrew Christo Engineers (ACE)	Structural
Paul Razgha	ACE	Structural
Richard Laramie	Resource Analysis, Inc.	Hydrology

Mr. Robert McMichael, Town of New London Selectman, accompanied the inspection team.

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
EARTH-FILLED ROCK CRIB		
Vertical alignment and movement	PAC	No deficiencies
Horizontal alignment and movement		No deficiencies noted; top width 17' ±
Condition at abutments		No deficiencies noted
Trespassing on slopes		Vertical faces on crib
Sloughing or erosion of slopes or abutments		Top of dam varies 1 foot in elevation due to erosion of soil by waves over dam in spring; only 2 feet of free-board at normal pond, lake often at top of dam in spring; pothole near gate house (other noted during May visit) ø 12" and 3 feet deep; soil may be washing out of large voids around outlet pipe
Rock slope protection		U/S and D/S faces of rubble stone masonry; many voids, serious at outlet pipe area; no movement of walls noted
Unusual movement or cracking at or near toe		None noted
Unusual downstream seepage		None noted, but lake level only 4 feet above toe of dam; seepage noted in May at toe of D/S wall 54 feet left of gate house
Piping or boils	PAC	None noted

CHECK LISTS FOR VISUAL INSPECTION

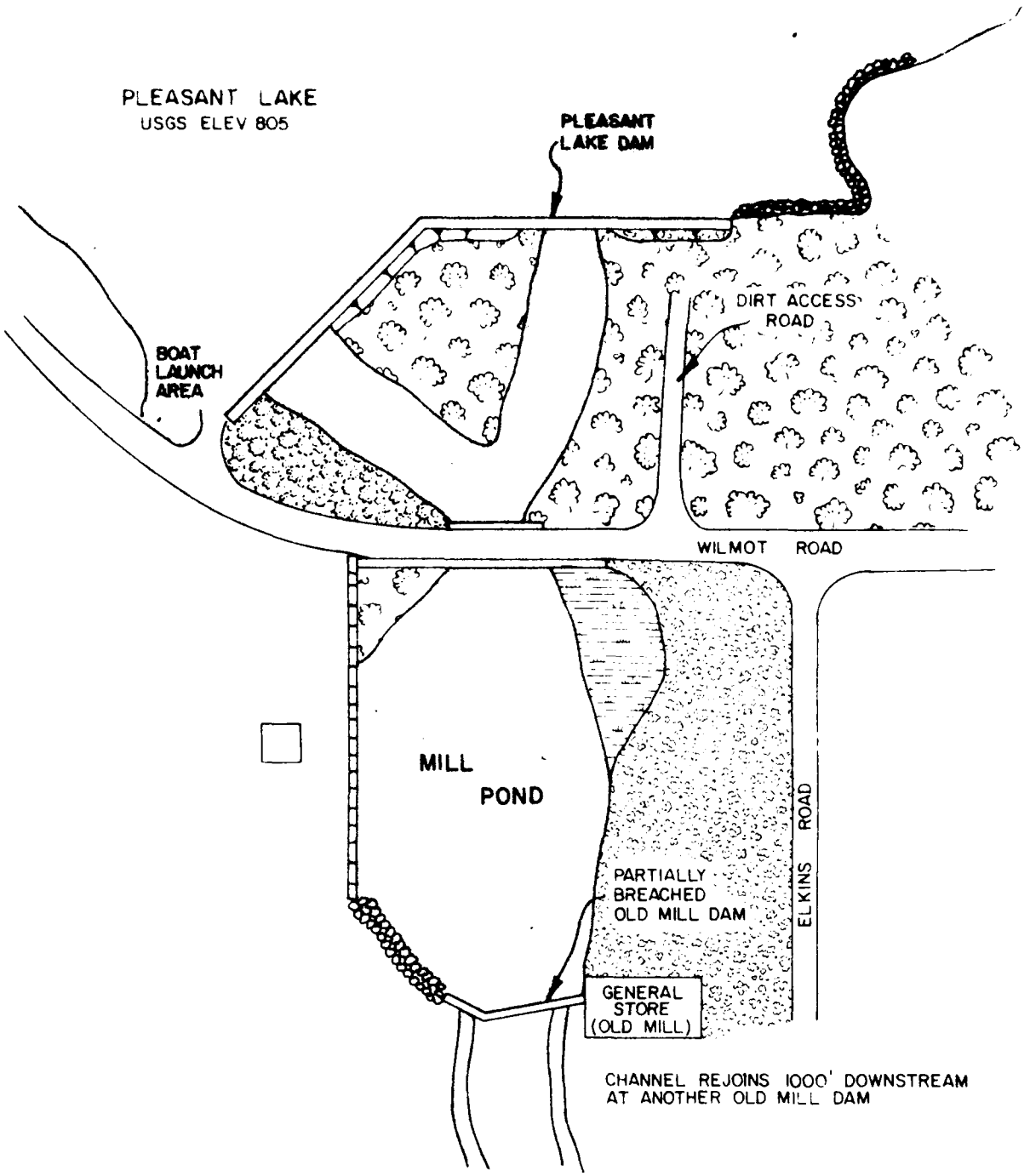
AREA EVALUATED	BY	CONDITION & REMARKS
Foundation drainage features	NAC	None evident or shown on plans
Concrete facing		Vertical crack 80' right of gate house; horizontal void 2" x 6", 30' left of gate house; minor spalling
Maintenance of slopes	NAC	Heavy brush on some parts of top of dam; trees in and near dam at abutments and spillway
OUTLET WORKS		
a. Approach Channel		
Bottom conditions	RM	Lake very low; rocky bottom
Rock slides or falls		None noted
Log boom		None; walkway over spillway serves same function
Control of debris		No deficiencies noted
Trees overhanging channel	AL	None creating potential for obstruction
b. Spillway	DP	
Condition of concrete		
General condition		Good
Erosion or cavitation		None noted
Spalling		Isolated small areas
Cracking		Minor fine random cracking
Condition of joints	DP	No deficiencies noted

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
Rusting or staining	PE	No deficiencies noted
Visible reinforcing		None noted
Seepage or effloures-cence		None noted
c. Sluiceway		
Condition of concrete		
General		Fair
Erosion or cavitation		Considerable amount of erosion; void between right side of gate and concrete wall
Spalling		None noted
Cracking		None noted
Condition of joints		No deficiencies noted
Rusting or staining		None noted
Visible reinforcing		Small amounts on right side
Gate		Concrete filled steel sluice gate in good condition, but serves no function due to stoplog weir; NHWRB recommended removal in 1974
Condition of stoplogs		Good
Adequately secured (tamperproof)		Must get in locked gate house to have access to stoplogs
	PE	

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
d. Outlet pipe	FR	Pipe in good condition; large void between pipe and old spillway; D/S headwall deteriorated with exposed reinforcing steel; 10 square feet of void in headwall
e. Gate house		Good condition; sluice gate operating mechanism in excellent condition, rebuilt 5 years ago
f. Existence of gage	FR	None
RESERVOIR		
a. Shoreline		
Evidence of slides		None noted
Potential for slides		Shoreline stable
b. Sedimentation		None noted
c. Upstream hazard areas in the event of backflooding		Numerous permanent and summer residences immediately on shoreline
d. Changes in nature of watershed (logging, construction, agriculture, etc.)		None noted
DOWNSTREAM CHANNEL		
Restraints on dam operation		None, given dam's limited operational capability
Potential flooded areas		Only one building appears to be within floodplain for a considerable distance D/S

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
OPERATION & MAINTENANCE FEATURES		
a. Reservoir regulation plan		
Normal procedures		Lake at El. 805 during summer (4' ± of stoplogs); in early fall, pull logs and open gate to get minimum level which will protect submerged pipes from freezing; every third year, extend drawdown period into summer for shore repairs
Emergency procedures		None; no warning system in effect
Compliance with designated plan		Satisfactory
b. Maintenance		
Quality		Dam requires considerable routine maintenance
Adequacy		Situation indicates a more rigorous program needed

APPENDIX B



GOLDBERG, ZOINO, DUNNICLIFF & ASSOC, INC GEOTECHNICAL CONSULTANTS NEWTON UPPER FALLS, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

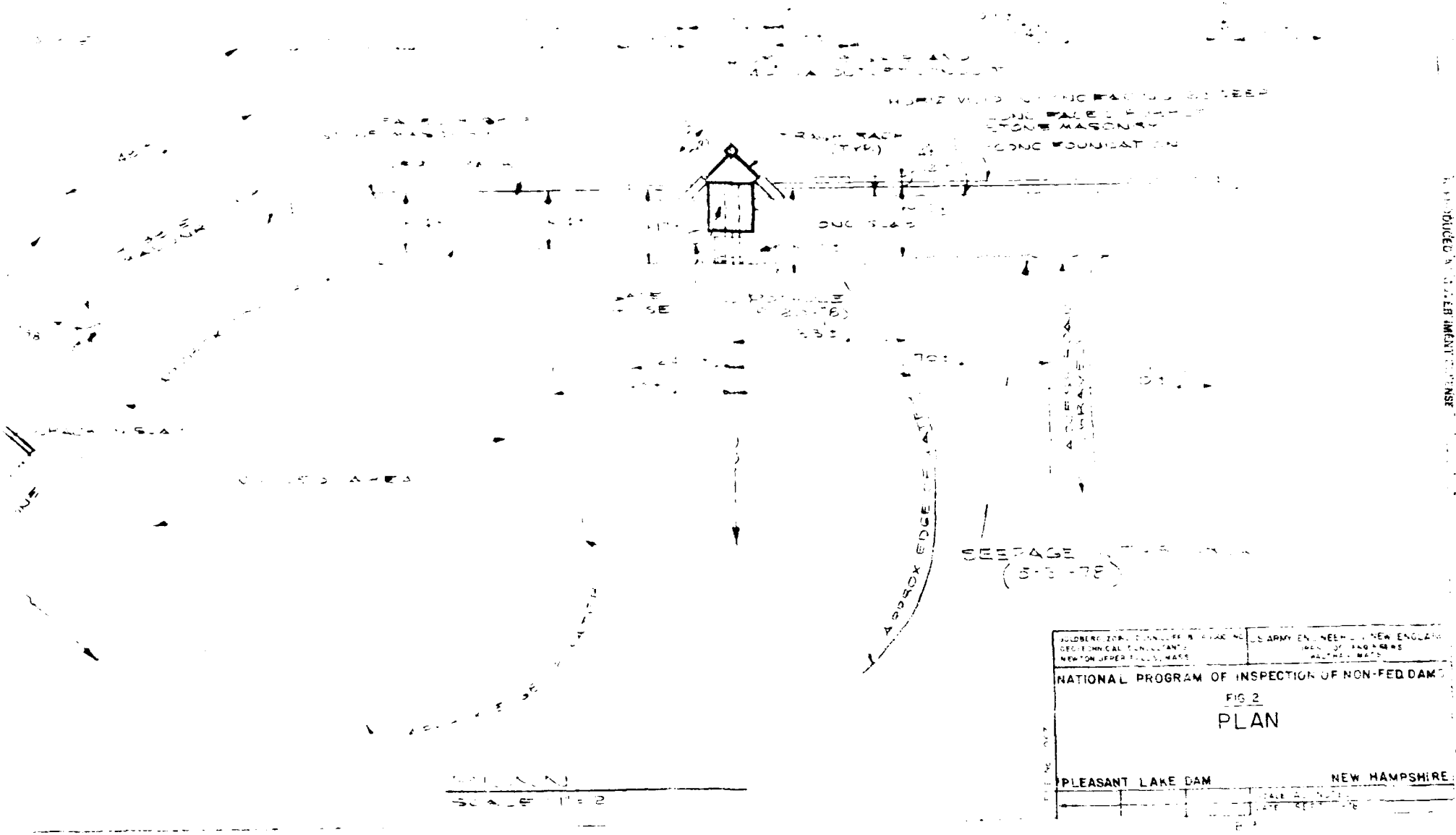
FIG. 1

SITE PLAN

FILE No 2067

PLEASANT LAKE — NEW HAMPSHIRE

SCALE	1" = 100'
DATE	NOV 1978

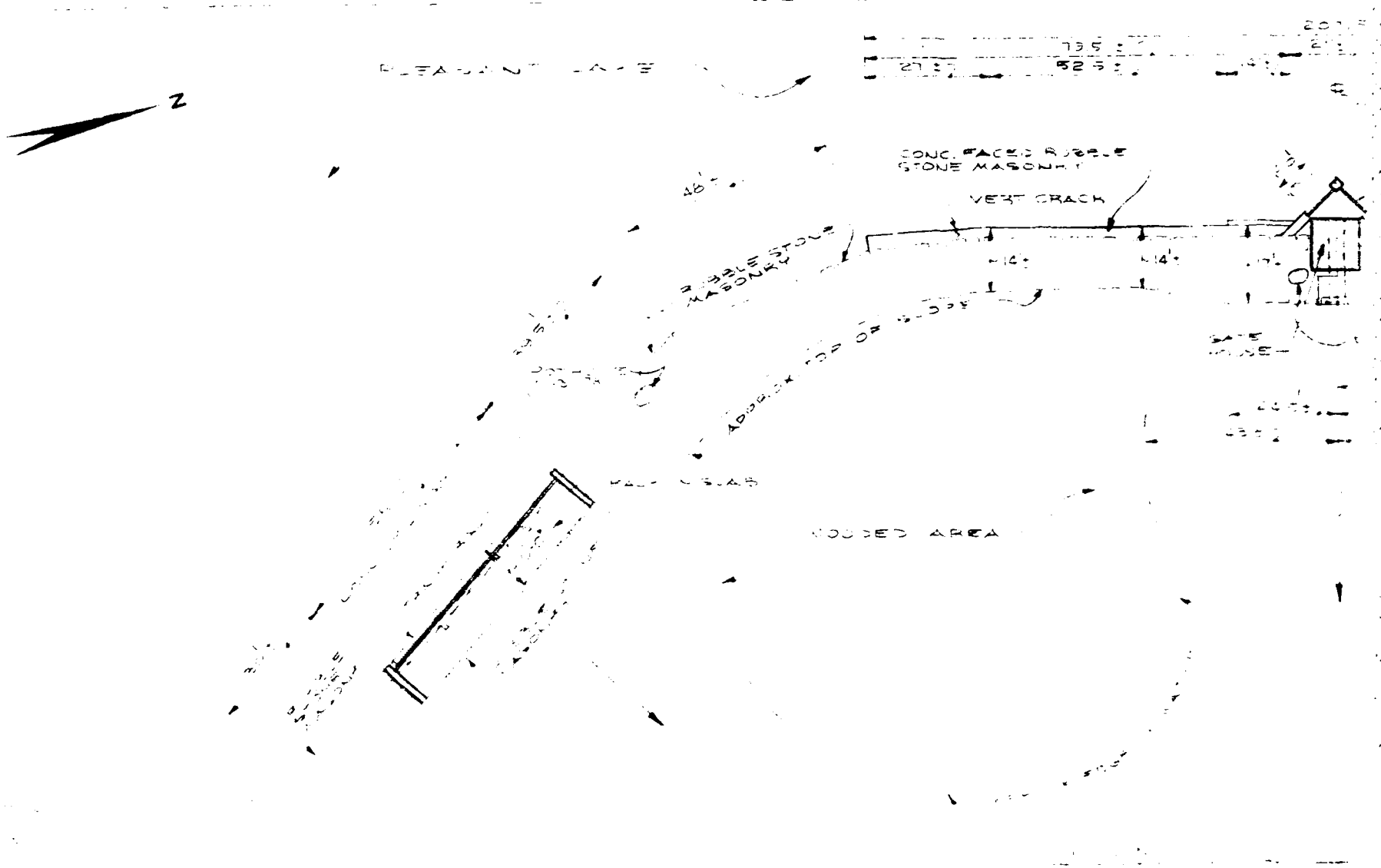


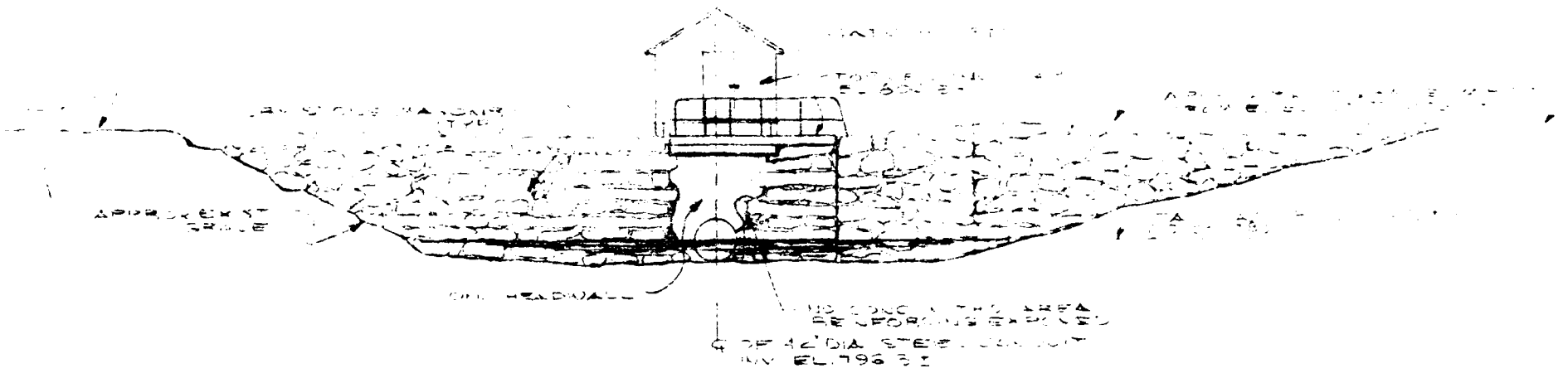
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

FIG 2

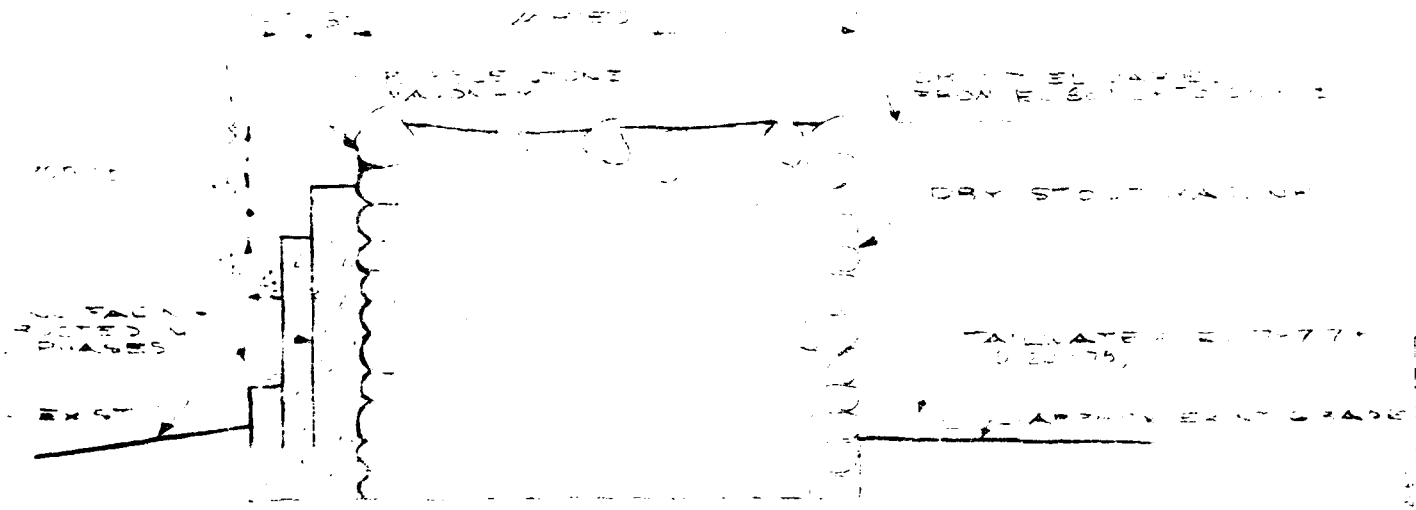
PLEASANT LAKE DAM — NEW HAMPSHIRE

PLAN


N
CONC. FACED RUBBLE STONE MASONRY
VERT CRACK
RUBBLE STONE MASONRY
HOUSED AREA



DAM ELEVATION



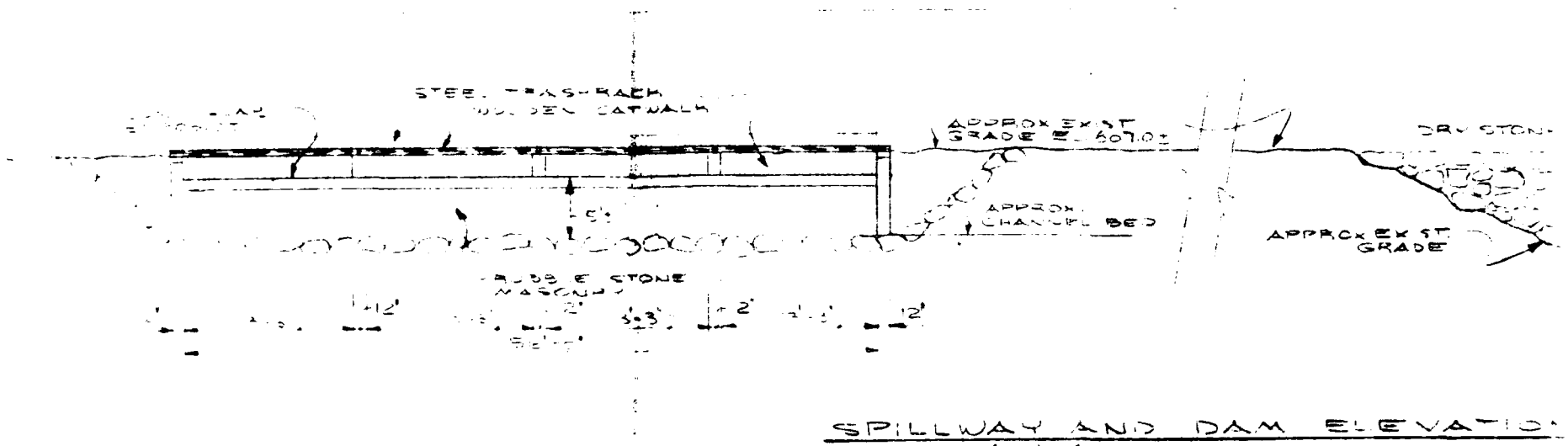
TYPICAL DAM SECTION

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

FIG 2

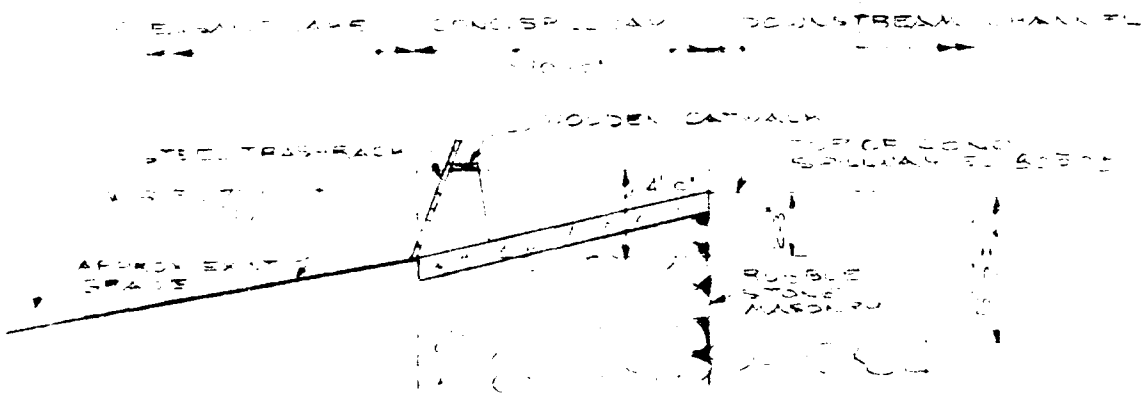
ELEVATION AND SECTIONS

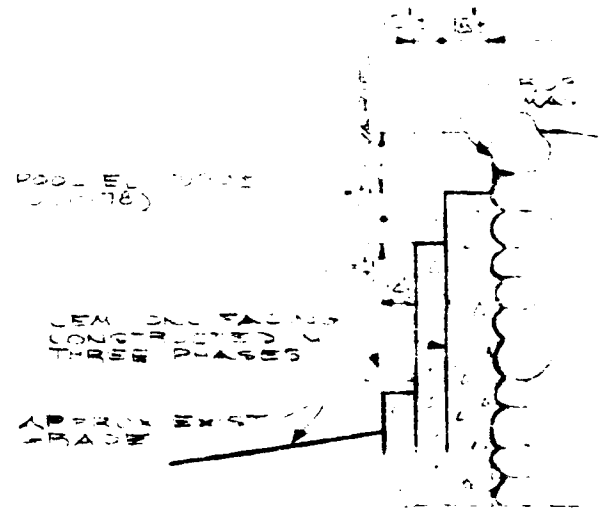
PLEASANT LAKE DAM — NEW HAMPSHIRE



SPILLWAY AND DAM ELEVATION

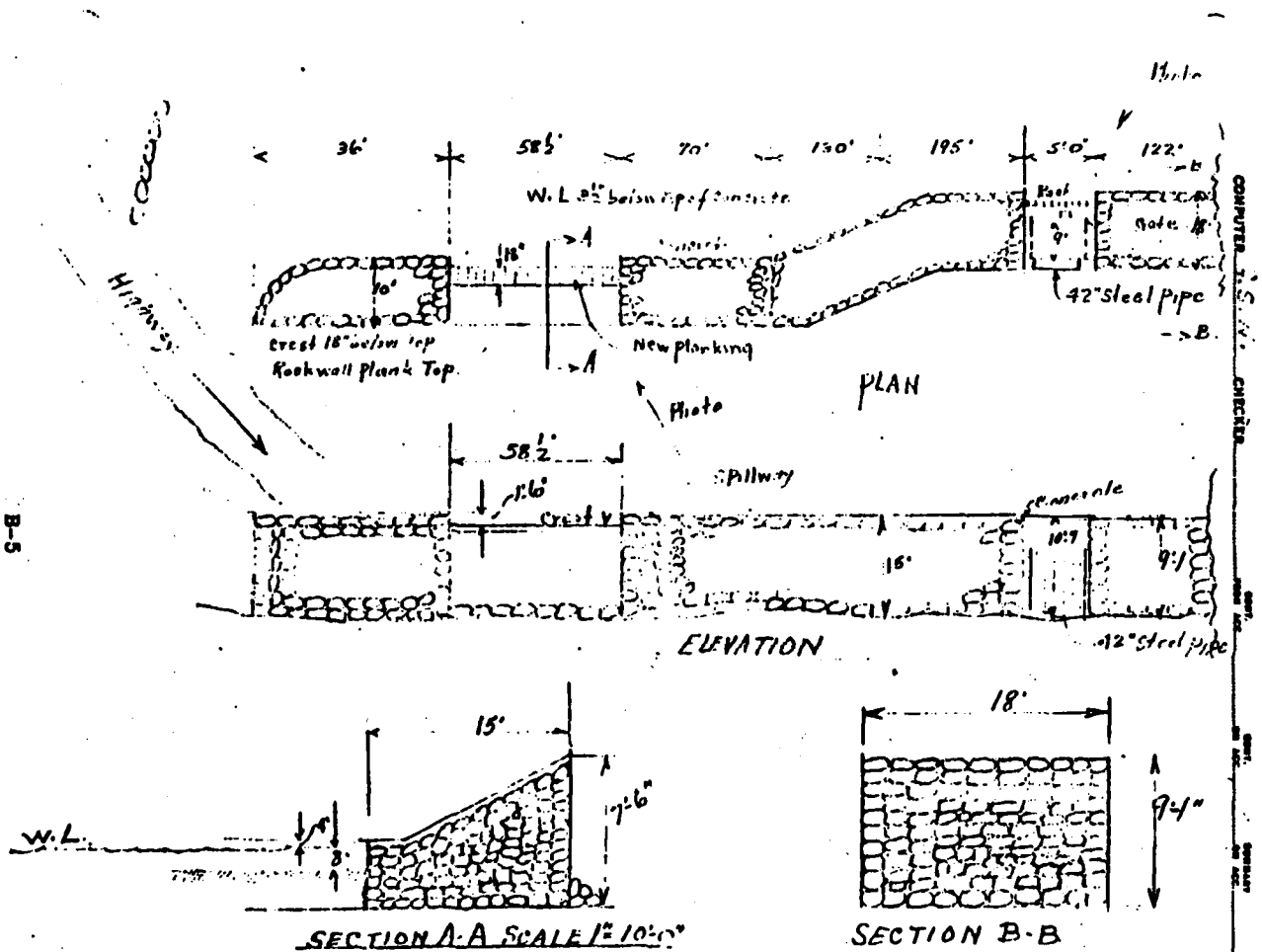
SCALE 1/8" = 1'-0"





TYPICAL SPILLWAY SECTION

SCALE 1/8" = 1'-0"



B-5

NEW HAMPSHIRE WATER RESOURCES BOARD CONCORD, N. H.

PROJECT

SUBJECT

COMPUTED BY U.S.G.V. CHECKED

DATE 7/14/32

FILE 176.02

The New Hampshire Water Resources Board, 37 Pleasant Street, Concord, NH 03301 maintains a data file on this dam. The Board can be reached at telephone number (603) 271-3406 or through the State Capitol operator at (603) 271-1110. Included in the file are the following:

(1) Report of a May 1977 inspection by the NHWRB

(2) Two pages of hydraulic calculations by the NHWRB dated January 1969

(3) Two 1939 reports by the New Hampshire Water Control Commission entitled "Data on Dams in New Hampshire" and "Data on Reservoirs and Ponds in New Hampshire."

(4) Miscellaneous correspondence with area residents concerning the level of Pleasant Lake and discharges from the dam.

MEMORANDUM

DATE: July 5, 1974

FROM: Francis C. Moore, Civil Engineer

SUBJECT: Pleasant Lake Dam, New London - #176.02

TO: Vernon A. Knowlton, Chief Engineer

On July 3, 1974, I inspected the dam at the outlet to Pleasant Lake in New London. The following suggested improvements are made:

1. Remove three stumps in the earth embankment on south (right bank) of gate house.

2. Place concrete facing (12" reinforced) in front of present masonry and concrete wall in front of embankment to 100 feet on right and to 100 feet on left of gate house carried down to impervious material or ledge and carried up to a point 12" to 24" higher than top of spillway abutment walls.

3. Grade off embankment and fill with impervious material up to within 4" of top of concrete upstream facing wall. Place 3/4" crushed stone on top of filled area to top of concrete upstream facing.

4. Remove fish screens, their frames, gate, gate house and discharge and replace with 2 - 5' wide stop log sections.

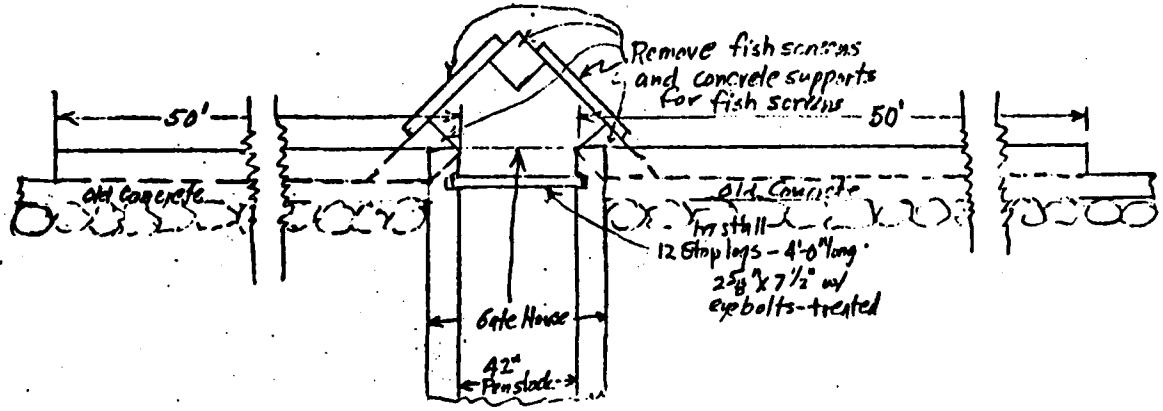
5. Cut suitable channel from spillway to just upstream of the old Route #11 bridge below the dam.

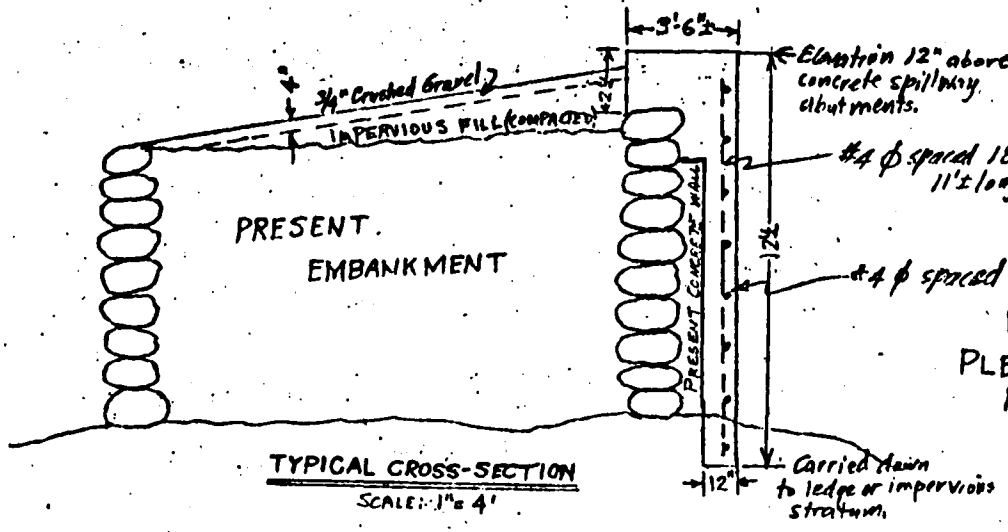
6. Carry embankment south of spillway to the existing road at an elevation 6" higher than the top of concrete facing. This embankment should be compacted impervious material with provision for public access to the lake for boating.

The gate is apparently partly open as nearly 12" water is running on bottom of the large discharge pipe.

During the July 1, 1973, flood, the embankment was overtopped and undermined at several points. On the south side of the gate house and to less extent on north of gate house serious erosion occurred due to overtopping and/or leakage by piping. At a point just south of gate house water in lake was only 8" higher than leakage water midway of gate house.

fcm/js





TYPICAL CROSS-SECTION
SCALE: 1" = 4'

RECONSTRUCTION OF
PLEASANT LAKE DAM
NEW LONDON, N.H.
JULY 1974

State of New Hampshire

WATER RESOURCES BOARD

37 Pleasant St.
Concord 03301

December 2, 1974

Mr. Robert K. Minard, President
Elkins Fish and Game Club
North Wilmot
Wilmot, New Hampshire 03286

Gentlemen:

In the past few weeks the repairs recently made to the Pleasant Lake Dam have been inspected by engineers from this office and in our opinion the repairs appear to have adequately sealed the majority of the leaks through the dam. The stoplog section which replaces the former gate should provide a suitable operating unit for this dam and should relieve the problems that you have had in the past. As for keeping this gate from leaking, we would recommend that you install a 4 " sleeve through one of the lower boards which would provide a minimum fish flow downstream of the dam. This could be gating.

In regard to our earlier recommendations, it is our belief that the critical work has been accomplished. The remaining work could be stretched out over a period of time keeping in mind however, that should an acceleration of erosion of the embankments occur your maintenance would necessarily have to be increased.

We beleive that our original estimate of $40,000. is a sound figure, as far as completely placing this dam in a safe maintenance free condition and over the next few years we hope the Elkins Fish and Game Club will be able to undertake these repairs in an orderly manner.

Very truly yours,

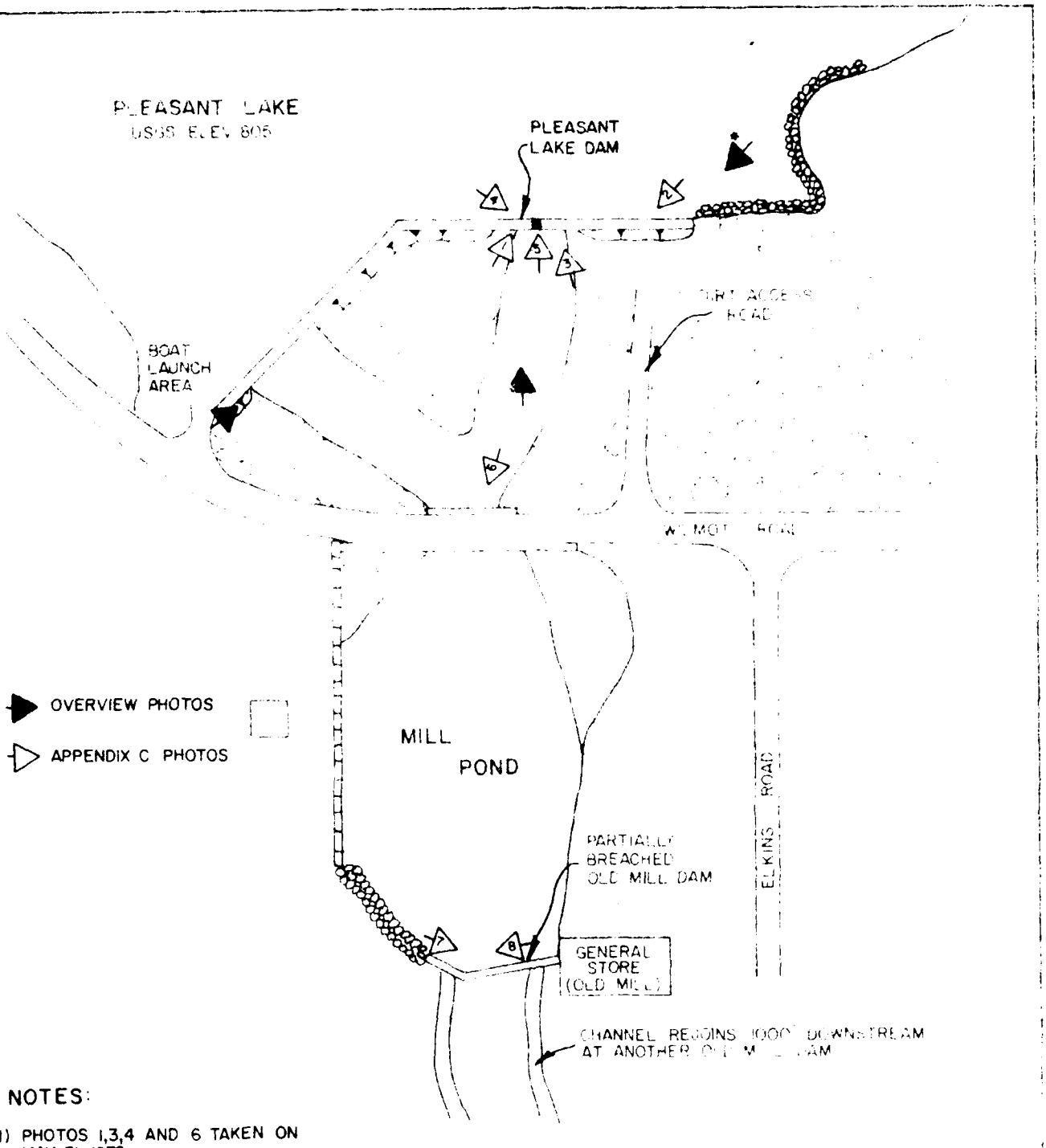
George M. McGee, Sr.
Chairman

GMMG/VAK/vi

c/c Rep. William F. Kidder
Box 99
New London, New Hampshire 03255

APPENDIX C

SELECTED PHOTOGRAPHS



NOTES:

1) PHOTOS 1,3,4 AND 6 TAKEN ON MAY 31, 1978
2) PHOTOS 2,5,7 AND 8 TAKEN ON SEPT 20, 1978
3) OVERVIEW PHOTO WITH ASTERIK (*) TAKEN SEPT 20, 1978 ALL OTHER OVERVIEW PHOTOS TAKEN MAY 31, 1978

GOLDBERG, ZOINO, DUNNICLIFF & ASSOCIATES
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

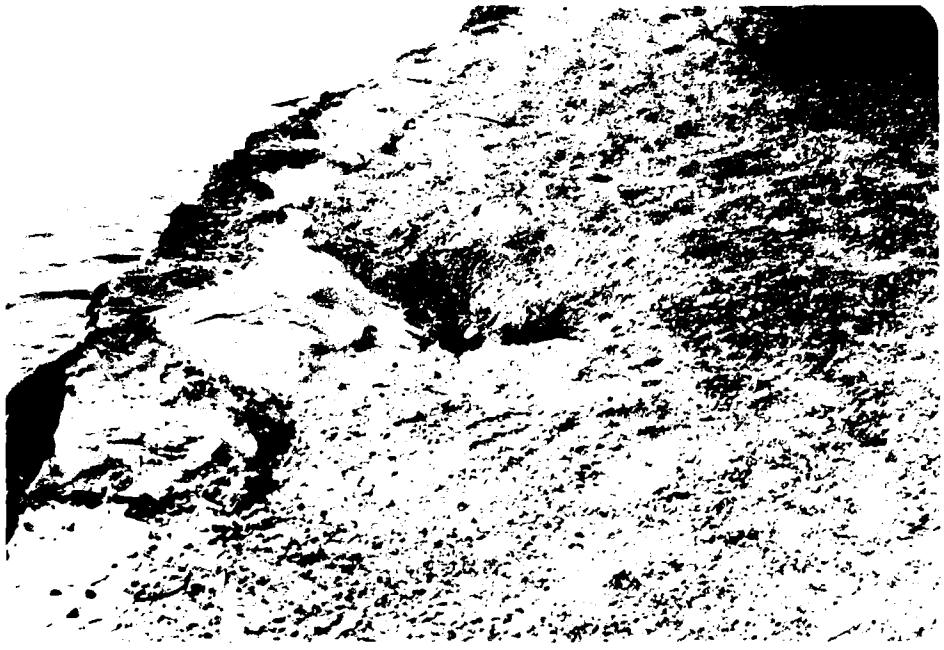
ARMY ENGINEER DISTRICT, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

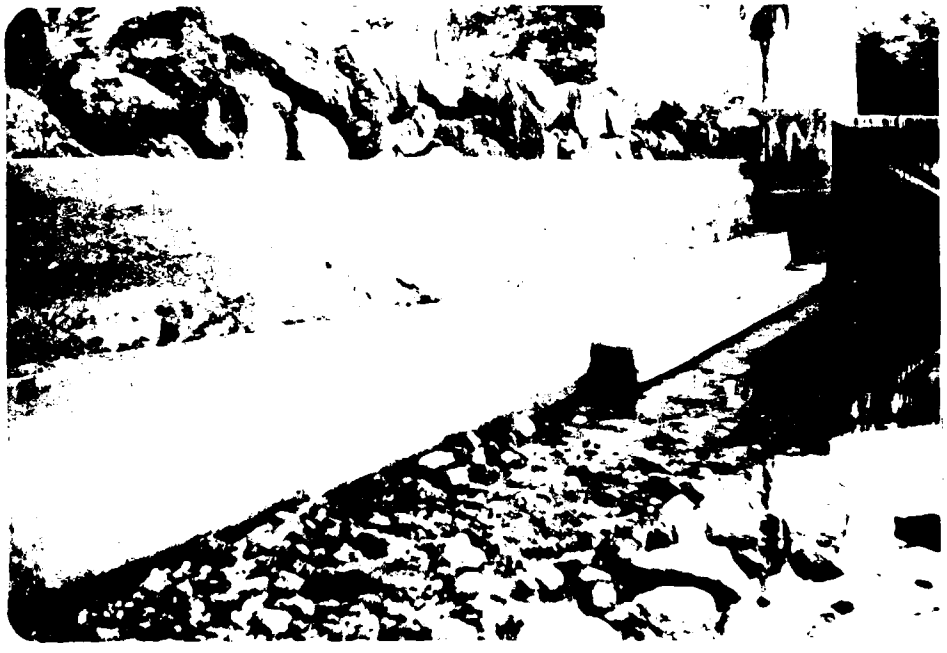
LOCATION AND ORIENTATION OF PHOTOS

PLEASANT LAKE — NEW HAMPSHIRE

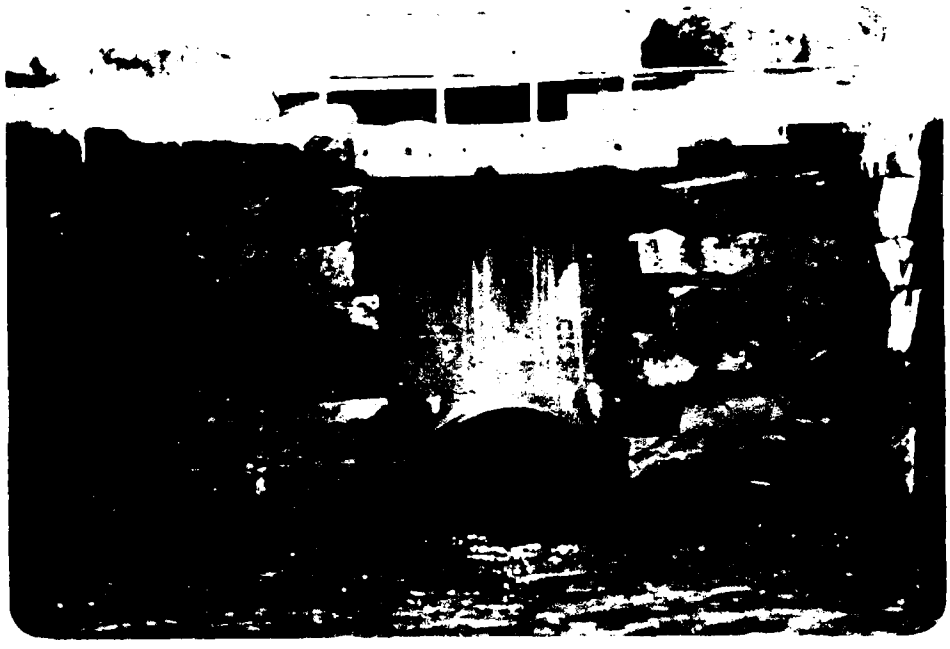
SCALE: AS SHOWN
DATE: JULY 1978



1. View of top of embankment showing erosion on upstream side

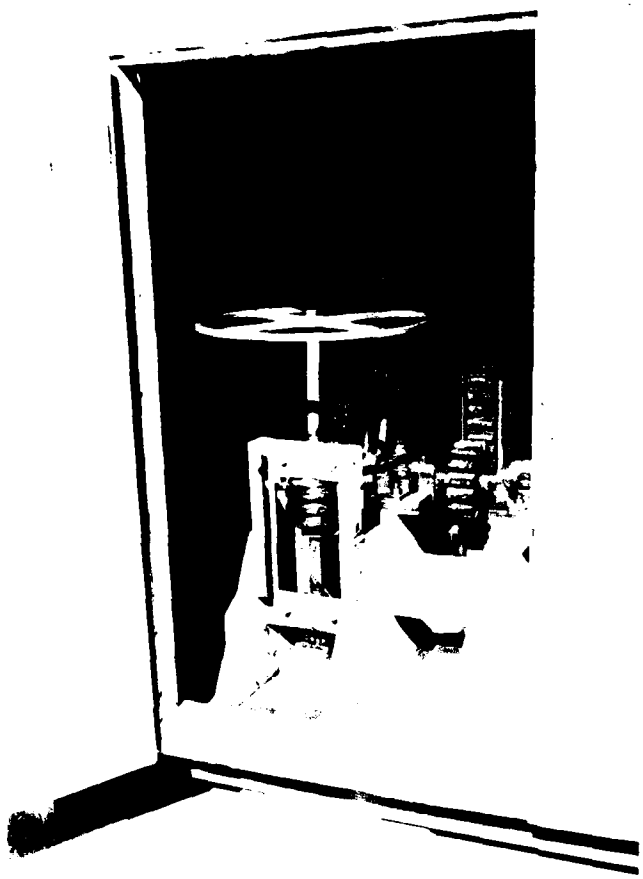


2. View from upstream showing concrete facing over old squared stone masonry dam



3. Detail of outlet showing voids around concrete above penstock and flow through dam with gate closed

4. View of inlet area and trashracks from right side



5. View of gate operating mechanism

6. View of road bridge downstream of dam creating hydraulic constriction

7. View of old mill dam from left side

8. View of left side of old mill dam

APPENDIX D

HYDROLOGIC/HYDRAULIC COMPUTATIONS

Pleasant Lake Dam

Size Classification = INTERMEDIATE

Hazard Classification = SIGNIFICANT

Based on the downstream conditions

Using the COE "Recommended Guidelines for Safety Inspection of Dams"

the test flood = ½ PMF to PMF

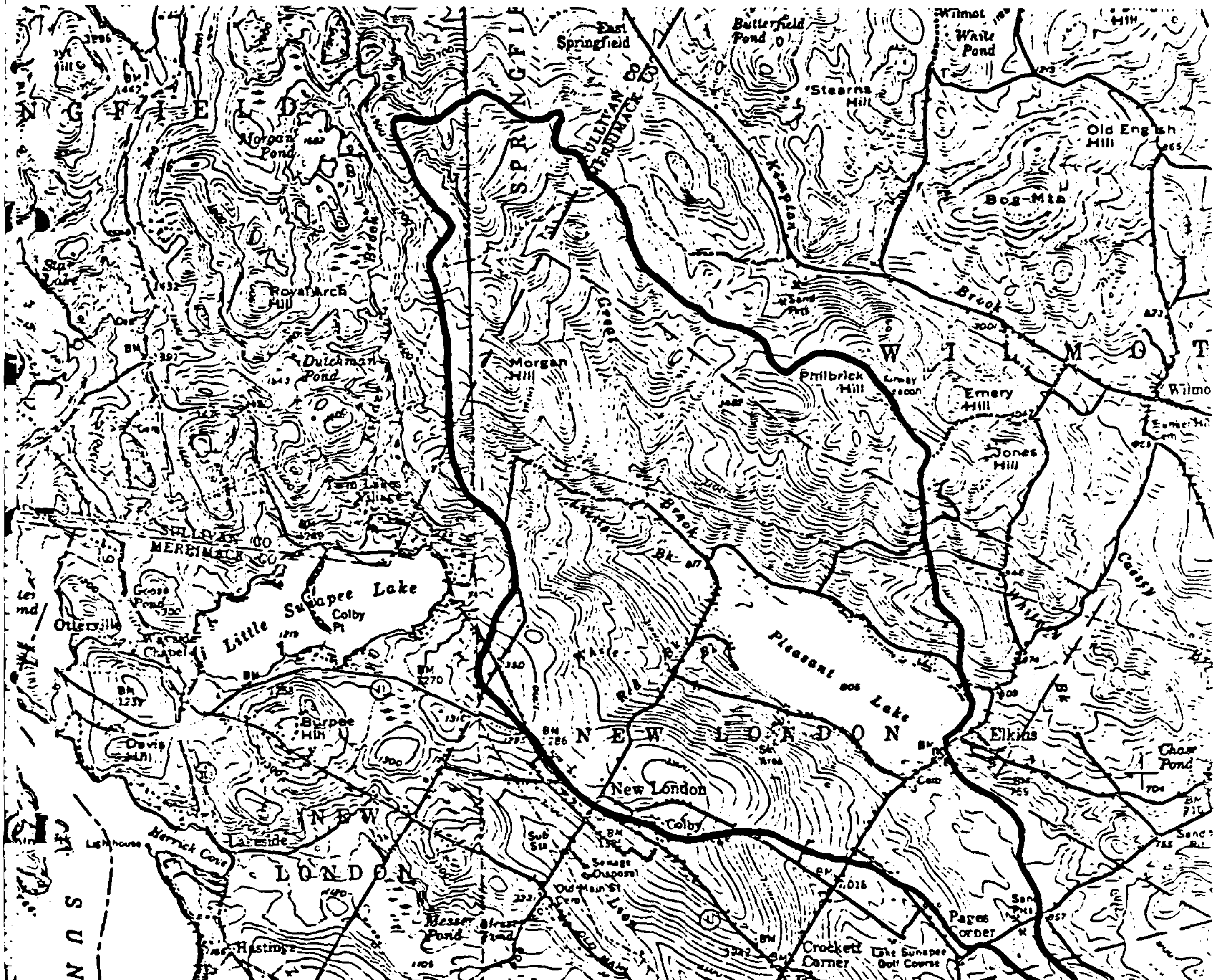
Given a drainage area of 11.35 mi^2 and a topography best described as rolling, the COE Maximum Probable Flood Peak Flow curve, yield:

PMF = 1600 cfs/mi^2 (11.35 mi^2)

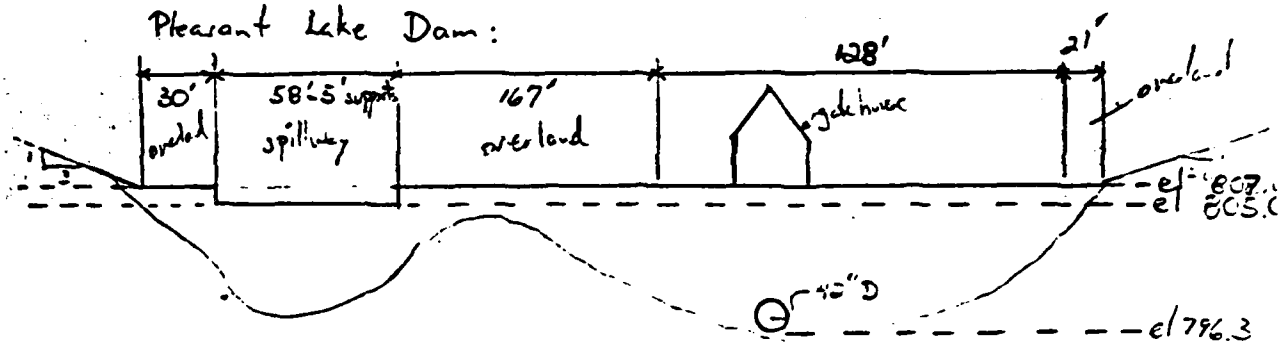
PMF ≈ 18,200 cfs

So the test flood is between 9100 cfs and 18,200 cfs.

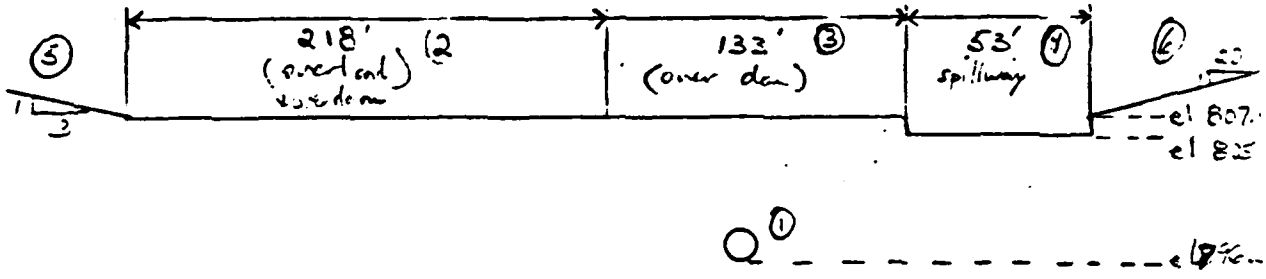
The test flood chosen is 16,000 cfs, to reflect the associated risks.


East Springfield
Butterfield Pond
Wilmot
White Pond
Stearns Hill
Old English Hill
Bog Mtn
Morgan Pond
Royal Arch Hill
Dutchman Pond
Kempton Brook
W I L M O T
Philbrick Hill
Emery Hill
Jones Hill
Morgan Hill
Twin Lakes Village
SULLIVAN CO
MERRIMACK CO
Little Sunapee Lake
Colby Pt
Otterville
Pleasant Lake
N E W L O N D O N
Elkins
Chase Pond
Burpee Hill
Davis Hill
New London
Colby
Lakeside
Herrick Cove
Lighthouse
NEW LONDON
Messer Pond
Hastings
Clark Pond
Crockett Corner
Pages Corner
Lake Sunapee Golf Course
S U N A P E E
St. Andrews
1 MILE
Rowell Hill
Blodgett Landing
Great Island
Baker Hill
Kings Hill
Maple Leaf Golf Course
North Sutton
Kezar Lake
Gile Pond
Fellows Hill
Sunset Hill
Wadleigh State Park
Kearsarge Valley Golf Course

Pleasant Lake Dam:



equivalent structure



Total length of dam = 404.0'

effective length of spillway = 53.0' (sharp crested)

effective length of dam ③ = 133.0'
(over dam only)

effective length of dam ② = 218.0'
(over dam + land

Dam Safety Job 148 10/30/78 RJH 4c-28

with h = 0 set at the spillway and assuming no stoplogs in place and the gate open the following relationships hold;

$-8.70 < h < 0$ $\quad Q_1 = (.56)(9.62\ ft^2)\sqrt{2g(h+8.7)}$ *

$Q_2 = Q_3 = Q_4 = Q_5 = Q_6 = 0$

$0 < h < 2$ $\quad Q_1 = (.56)(9.62)\sqrt{2g(h+8.7)}$

$Q_4 = (3.3)(53.0)(h)^{3/2}$

$Q_2 = Q_3 = Q_5 = Q_6 = 0$

$2 < h$ $\quad Q_1 = (.56)(9.62)\sqrt{2g(h+8.7)}$

$Q_2 = (2.8)(218)(h-2)^{3/2}$

$Q_3 = (3.0)(133)(h-2)^{3/2}$

$Q_4 = (3.3)(53.0)(h-2)^{3/2}$

$Q_5 = (2.8)(3(h-2))(.5(h-2))^{3/2}$

$Q_6 = (2.8)(20(h-2))(.5(h-2))^{3/2}$

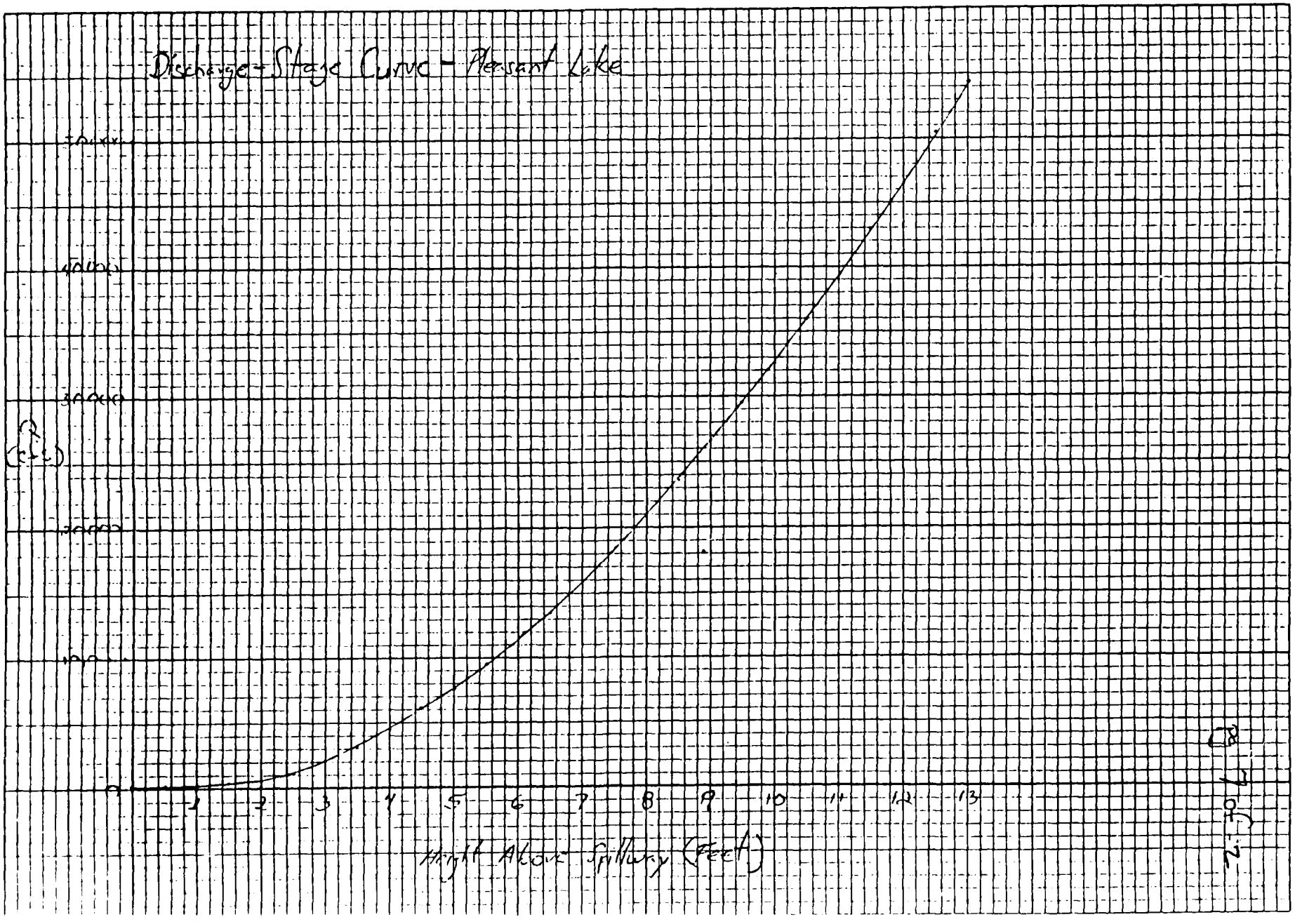
The following pages contain a computer program written to compute the above equations and its output

* Underflow sluice gate equation, Rouse Engineering Hydraulics, p. [illegible]

```
100 REMARK: DISCHARGE CALCULATIONS FOR PLEASANT LAKE, GATE OPEN
110 PAGE
120 E=1.5
130 PRINT "DISCHARGE FROM PLEASANT LAKE - GATE OPEN"
140 PRINT USING 150:
150 IMAGE // 2T "HEAD"30T"DISCHARGE"
160 PRINT USING 170:
170 IMAGE 1T"(feet)"32T"(cfs)"
180 PRINT "          TOTAL    GATE    SPILLWAY   DAM CREST   DAM CREST";
190 PRINT "   SIDE SLOPE"
200 PRINT USING 210:
210 IMAGE 39T"  (only)   (over land)"
220 REMARK: Q1=FLOW THRU CULVERT,Q2=FLOW OVER DAM + LAND,Q3=FLOW OVER
230 REMARK: DAM CREST ONLY,Q4=FLOW OVER SPILLWAY,Q5=FLOW OVER SIDE SLOPE
240 REMARK: AND Q6=FLOW OVER SIDE SLOPE (see diagram)
250 FOR H=0 TO 13 STEP 0.5
260 Q1=0.56*9.62*(2*32.2*(H+8.7))↑0.5
270 Q4=3.3*53*H↑E
280 Q2=0
290 Q3=0
300 Q5=0
310 Q6=0
320 IF H<=2 THEN 370
330 Q2=2.8*218*(H-2)↑E
340 Q3=3*133*(H-2)↑E
350 Q5=2.8*(3*(H-2))*(0.5*(H-2))↑E
360 Q6=2.8*(20*(H-2))*(0.5*(H-2))↑E
370 Q7=Q1+Q2+Q3+Q4+Q5+Q6
380 Q8=Q5+Q6
390 PRINT USING 400:H,Q7,Q1,Q4,Q3,Q2,Q8
400 IMAGE 1T,2D.2D,9D,8D,10D,11D,11D,13D
410 NEXT H
420 END
```

DISCHARGE FROM PLEASANT LAKE - GATE OPEN

HEAD (feet)	DISCHARGE (cfs) TOTAL	GATE	SPILLWAY	DAM CREST (only)	DAM CREST (over land)	SIDE SLOPE
0.00	128	128	0	0	0	0
0.50	193	131	62	0	0	0
1.00	310	135	175	0	0	0
1.50	459	138	321	0	0	0
2.00	636	141	495	0	0	0
2.50	1197	145	691	141	216	4
3.00	2089	148	909	399	610	23
3.50	3213	151	1145	733	1121	63
4.00	4537	154	1399	1129	1726	129
4.50	6042	157	1670	1577	2413	225
5.00	7715	160	1955	2073	3172	355
5.50	9550	163	2256	2613	3997	522
6.00	11540	166	2570	3192	4883	729
6.50	13681	169	2898	3809	5827	978
7.00	15969	171	3239	4461	6824	1273
7.50	18402	174	3592	5147	7873	1615
8.00	20977	177	3958	5864	8971	2008
8.50	23694	179	4334	6612	10115	2453
9.00	26550	182	4722	7390	11305	2952
9.50	29546	184	5121	8195	12537	3507
10.00	32679	187	5531	9028	13812	4122
10.50	35951	189	5951	9888	15127	4796
11.00	39359	192	6381	10773	16481	5533
11.50	42905	194	6821	11683	17873	6334
12.00	46587	197	7270	12617	19303	7200
12.50	50407	199	7730	13576	20768	8134
13.00	54363	201	8198	14557	22269	9137



Pleasant Lake

- Storage - Stage Relationship -

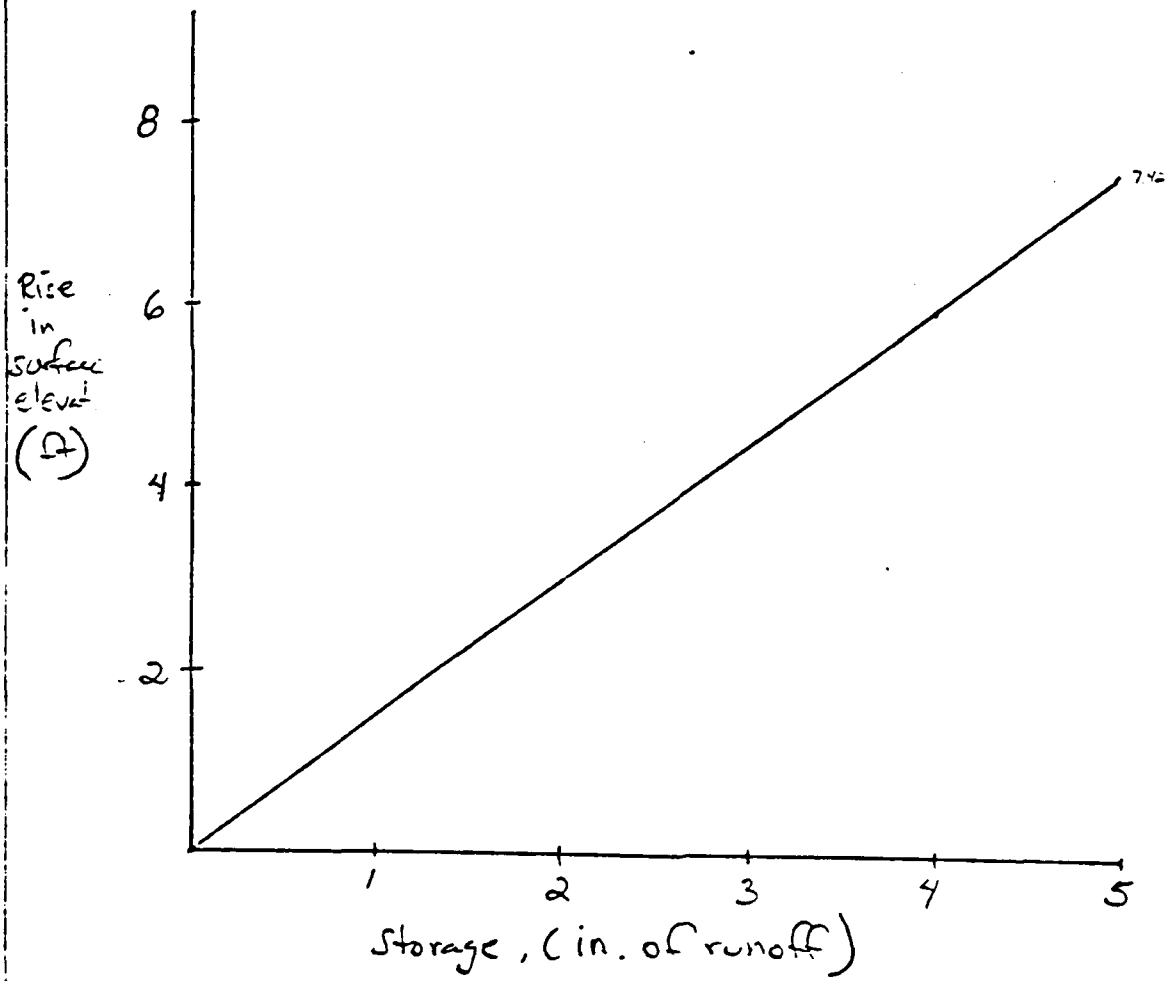
Surface Area of the pond at its normal level is:
$A_s = 575 \text{ acres} = 0.8984 \text{ mi}^2$

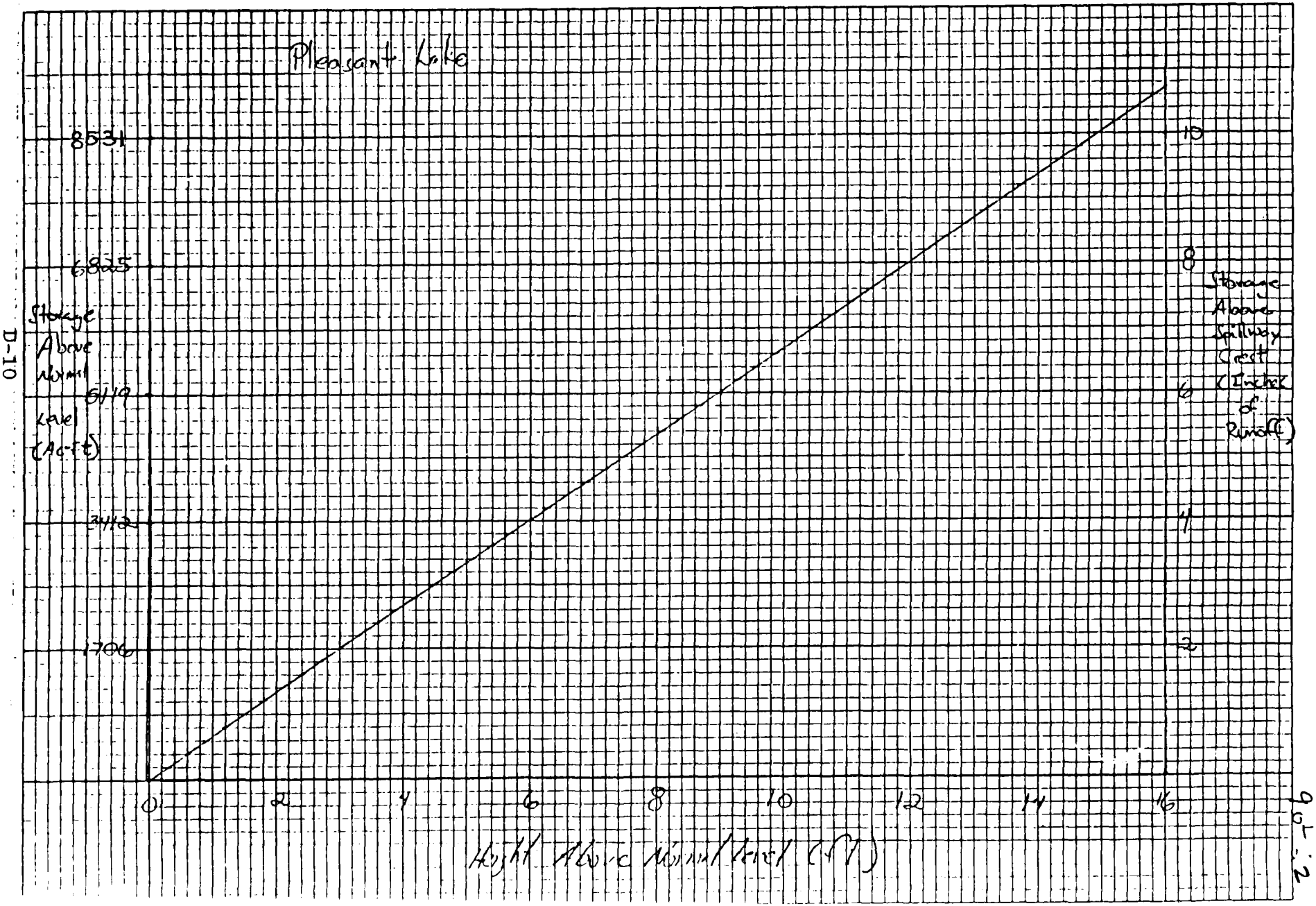
Drainage Area = 11.35 mi^2

So 1 inch of runoff would produce:

$1\text{"runoff} \rightarrow 1\text{"}\left(\frac{11.35 \text{ mi}^2 (640 \text{ ac/mi}^2)}{408 \text{ ac}}\right) = \underset{\text{surface}}{17.80} \text{ inch rise in water}$

$\therefore$ 1 foot of rise results from .67 in of runoff





D-10

9 of 12

Reduction in flow due to storage:

A total storm volume of 16.5" is assumed (Lake A = 8050)

Using the COE suggested methodology (with additional factors):

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{STOR1}{16.5}\right)$$

① Q_{P_1} = 16000 cfs ⟶ H_1 = 7.01' above the spillway crest

7.01' yields ⟶ (7.01)(.67) = 4.73" of surcharge storage

Q_{P_2} = 16000$\left(1 - \frac{4.73}{16.5}\right)$ = 11413 cfs

② Q_{P_2} = 11413 ⟶ H_2 = 5.97' above the spillway crest

5.97' yields (5.97)(.67) = 4.00" surcharge

Q_{P_3} = 16000$\left(1 - \frac{4.00}{16.5}\right)$ = 12121 cfs

③ Q_{P_3} = 12121 cfs ⟶ H_3 = 6.14' above the spillway crest

6.14' yields (6.14)(.67) = 4.11' surcharge

Q_{P_4} = 16000$\left(1 - \frac{4.11}{16.5}\right)$ = 12015 cfs

④ Q_{P_4} = 12015 cfs ⟶ H_4 = 6.11' above the spillway crest

6.11' yields (6.11)(.67) = 4.09" surcharge

⑤ Final Q_P = 16000$\left(1 - \frac{(STOR3 - \frac{1}{2}(STOR3 - STOR4))}{16.5}\right)$

$\frac{1}{2}(STOR3 - STOR4) = \frac{1}{2}(4.09 - 4.11) = 4.10$

Q_{P_5} = 16000$\left(1 - \frac{4.10}{16.5}\right)$ = <u>12025 cfs</u>

which is about 6.11 feet above the spillway or 4.11 feet above the dam crest.

Pleasant Lake

Calculation of Estimated Downstream Dam Failure Flood Stages – Based on COE "Rule of Thumb" Guidance, April 1978.

STEP 1: Reservoir Storage at time of failure

Assume failure occurs when the dam is overtopped (el = 807') and then:

Storage = Normal + Surcharge = 1850 + 2.0(575 ac)

= 3000 acre-ft

STEP 2: Peak Failure Flow

$$Q_{P_1} = \frac{8}{27} W_b \sqrt{g}\, Y_0^{3/2}$$

W_b < 40% width = .4(181) = 72.40

(181 ↑ width spillway + dam)

use → 70 ft

Y_0 = 807 − 796.3 = 10.70 ft

$$Q_{P_1} = \frac{8}{27}(70)(32.2)^{1/2}(10.7)^{3/2}$$

= 4120 cfs, say 4100 cfs

STEP 3: Develop Stage-Discharge Rating for Downstream Reaches

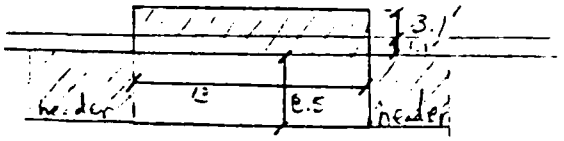
Assumed Cross-sections for the reaches downstream of Pleasant Lake are shown on the following pages as well as on the USGS quad photocopy.
Also, computer output tables of Stage-Discharge Relationships for each reach are attached.

Pleasant Lake

Reach 1 – from Pleasant Lake Dam to first bridge

channel 200 feet long - flow in this channel will be controlled by the bridge culvert and embankment and therefore is analyzed differently, using FHWA Nomographs.

Culvert –

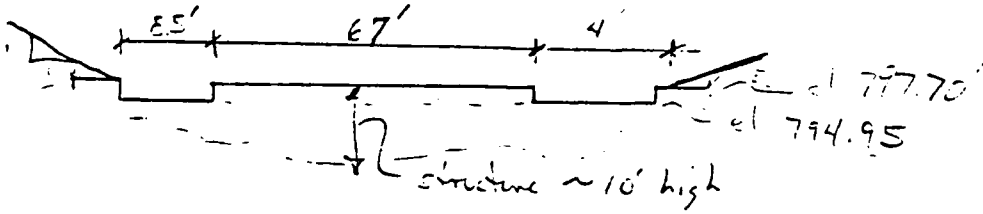


The water level behind the bridge will be assumed to be equal to the depth behind the dam at time of failure (10.7 ft)

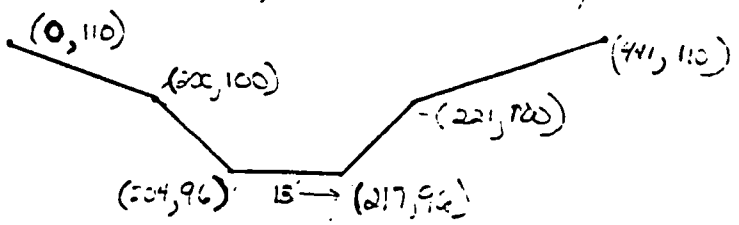
Reach 2 – from bridge to Mill Dam

this reach is essentially the Mill Pond, determination will be developed using the computer output stage-discharge for the dam's flow capacity.

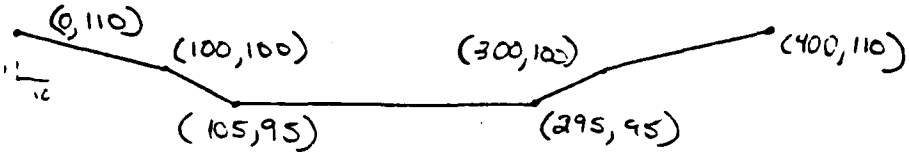
The dam is as shown:



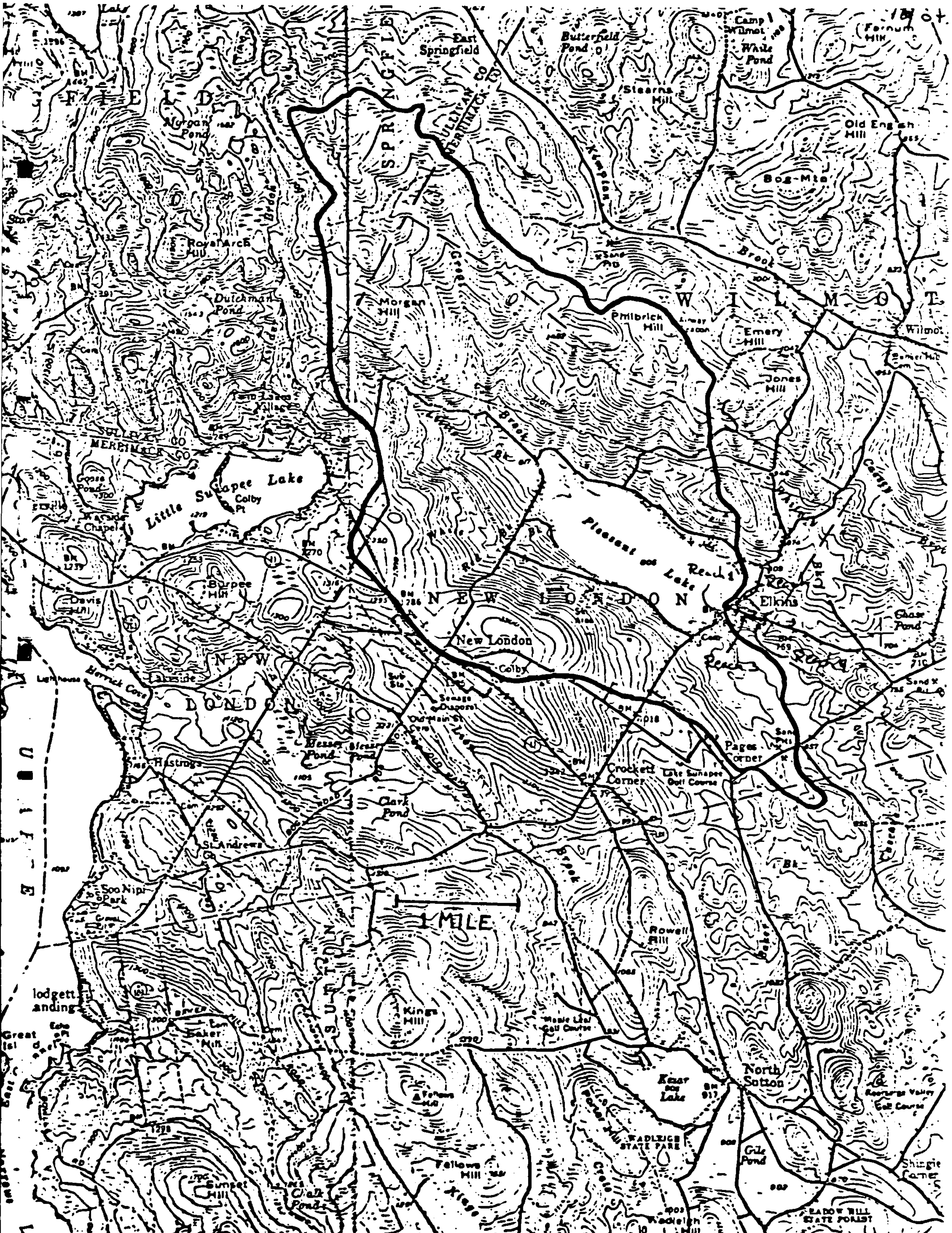
Reach 3 – Mill Dam to next pond – evaluated with stage-discharge relation: length = 1000' slope = 0.01 n = .01



Reach 4 - Sythe Hill Pond
length = 500' width = 200' slope = 0.001 n = .035



Downstream of this reach is only sparsely settled and is therefore not evaluated


East Springfield
Butterfield Pond
Camp Wilmot
White Pond
Farnum Hill
Stearns Hill
Old English Hill
Bog Mtn
Morgan Pond
Royal Arch Hill
Dutchman Pond
Morgan Hill
Philbrick Hill
Emery Hill
Jones Hill
W I L M O T
Wilmot
Kimpton
Brook
Little Sunapee Lake
Colby Pt
Goose Pond
Pleasant Lake
Davis Hill
Burpee Hill
N E W L O N D O N
New London
Colby
Elkins
Chase Pond
Herrick Cove
Lakeside
Hastings
Messer Pond
Clark Pond
Crockett Corner
Lake Sunapee Golf Course
Pages Corner
St. Andrews
Soo Nipi Park
1 MILE
Rowell Hill
Kings Hill
Blodgett Landing
Baker Hill
Kezar Lake
North Sutton
Gile Pond
Fellows Hill
Sunset Hill
Clark Pond
Wadleigh State Park
Wadleigh Hill
Shingle Camp
Meadow Hill State Forest

DEPTH	ELEV	AREA	WPER	HYD-R	AR2/3	Q
0.0	96.0	0.0	0.0	0.0	0.0	0.0
0.5	96.5	6.8	14.4	0.5	4.1	15.2
1.0	97.0	14.0	15.8	0.9	12.9	48.1
1.5	97.5	21.8	17.2	1.3	25.4	94.6
2.0	98.0	30.0	18.7	1.6	41.2	153.4
2.5	98.5	38.8	20.1	1.9	60.1	223.9
3.0	99.0	48.0	21.5	2.2	82.1	305.6
3.5	99.5	57.8	22.9	2.5	107.0	398.7
4.0	100.0	68.0	24.3	2.8	135.0	503.0
4.5	100.5	83.8	45.3	1.8	126.1	469.8
5.0	101.0	110.0	66.4	1.7	154.1	574.0
5.5	101.5	146.8	87.4	1.7	207.4	772.5
6.0	102.0	194.0	108.4	1.8	286.0	1065.4
6.5	102.5	251.8	129.4	1.9	392.4	1461.5
7.0	103.0	320.0	150.5	2.1	529.4	1971.9
7.5	103.5	398.8	171.5	2.3	700.1	2607.8
8.0	104.0	488.0	192.5	2.5	907.6	3380.6
8.5	104.5	587.8	213.5	2.8	1154.8	4301.5
9.0	105.0	698.0	234.6	3.0	1444.6	5381.3
9.5	105.5	818.8	255.6	3.2	1779.9	6630.3
10.0	106.0	950.0	276.6	3.4	2163.5	8058.9
10.5	106.5	1091.8	297.6	3.7	2597.9	9677.0
11.0	107.0	1244.0	318.6	3.9	3085.7	11494.3
11.5	107.5	1406.8	339.7	4.1	3629.6	13520.3
12.0	108.0	1580.0	360.7	4.4	4232.0	15764.3
12.5	108.5	1763.8	381.7	4.6	4895.4	18235.3
13.0	109.0	1958.0	402.7	4.9	5622.1	20942.3
13.5	109.5	2162.8	423.8	5.1	6414.5	23894.0
14.0	110.0	2378.0	444.8	5.3	7274.9	27098.9

PLEASANT LAKE - REACH 3

DEPTH	ELEV	AREA	WPER	HYD-R	AR2/3	Q
0.0	95.0	0.0	0.0	0.0	0.0	0.0
0.5	95.5	95.3	191.4	0.5	59.8	62.6
1.0	96.0	191.0	192.8	1.0	189.8	198.7
1.5	96.5	287.3	194.2	1.5	372.9	390.5
2.0	97.0	384.0	195.7	2.0	602.1	630.4
2.5	97.5	481.3	197.1	2.4	873.0	914.1
3.0	98.0	579.0	198.5	2.9	1182.5	1238.2
3.5	98.5	677.3	199.9	3.4	1528.3	1600.3
4.0	99.0	776.0	201.3	3.9	1908.6	1998.4
4.5	99.5	875.3	202.7	4.3	2321.8	2431.1
5.0	100.0	975.0	204.1	4.8	2766.6	2896.8
5.5	100.5	1077.5	214.2	5.0	3165.1	3314.1
6.0	101.0	1185.0	224.2	5.3	3597.2	3766.5
6.5	101.5	1297.5	234.3	5.5	4063.7	4255.0
7.0	102.0	1415.0	244.3	5.8	4565.8	4780.7
7.5	102.5	1537.5	254.4	6.0	5104.5	5344.7
8.0	103.0	1665.0	264.4	6.3	5680.7	5948.1
8.5	103.5	1797.5	274.5	6.5	6295.6	6591.9
9.0	104.0	1935.0	284.5	6.8	6950.0	7277.1
9.5	104.5	2077.5	294.6	7.1	7644.9	8004.7
10.0	105.0	2225.0	304.6	7.3	8381.3	8775.8
10.5	105.5	2377.5	314.7	7.6	9160.2	9591.3
11.0	106.0	2535.0	324.7	7.8	9982.4	10452.3
11.5	106.5	2697.5	334.8	8.1	10849.0	11359.6
12.0	107.0	2865.0	344.8	8.3	11760.8	12314.3
12.5	107.5	3037.5	354.9	8.6	12718.7	13317.3
13.0	108.0	3215.0	364.9	8.8	13723.6	14369.5
13.5	108.5	3397.5	375.0	9.1	14776.5	15472.0
14.0	109.0	3585.0	385.0	9.3	15878.2	16625.5
14.5	109.5	3777.5	395.1	9.6	17029.6	17831.1

PLEASANT LAKE - REACH 4

Design Lake

STEP 4 - Calculate Downstream Attenuation

Reach 1: This reach is short and therefore the depth and flow rate are controlled by the downstream conditions; the bridge. Applying the height of water when the dam breaks to the bridge the flow through the culvert is found using the FHWA nomographs for box culvert flow:

Depth of water = 10.7 ft

Culvert size = 13 ft by 8.5 ft

$\frac{\text{depth}}{\text{height of culvert}} = \frac{10.7}{8.5} = 1.26$

From the nomograph → ≈ 88 cfs per foot wide

Total culvert capacity = (88)(13) = 1144 cfs, say 1150

Since the roadway is overtopped the flow over it must be considered. The roadway is 9.6 feet above the stream bottom which means it is overtopped by 1.1 feet.
Assuming a 250' width of overtopping and using the equation for calculating flow over the weir

$Q_o = C \cdot L(H)^{1.5}$

where C = 2.8, broad-crested
L = 250'
H = 1.1

$Q_o = (2.8)(250)(1.1)^{1.5}$

$Q_o \approx 810$ cfs

So the total flow passed along to Reach 2 is

$Q = 1150 + 810 = 1960$, say 2000 cfs

Reach 2: Mill Pond (300')

Q = 2000 cfs, no attenuation of flow thru reach

From computer Tabulation of Discharge vs. Head this would result in 5.8' of Head over the spillway or 3.8' over the dam crest.

Adjacent Store has 1st floor ~ 2' above dam crest

∴ Therefore possible structural damage to this a similar adjacent buildings. Shallow depth of flooding (<2') probably would not endanger lives.

Reach 3 Stream Channel and 2nd Mill Pond (1000')

Reach is in 2 parts: 1) Steeply sloping narrow channel
2) Mill Pond behind Dam

1st Section Again assume no significant attenuation in this short reach, ie Q = 2000 cfs

From computer Tabulation of Reach Capacity vs. Depth, flow depth corresponding to a flow of 2000 cfs is:

7.0 feet

2nd Section From computer Tabulation of Discharge vs Head for 2nd Dam D/S of Pleasant Lake:

for Q = 2000 cfs, H = 4.3'

Thus would have a flood stage profile varying from 7.0' in the upper reach to 4.3' at the Mill Dam — see attached profile.

Residential Street paralleling this reach has building ~ 8' above stream invert. Thus flood waters would be ~ 1 foot lower — causing some structural damage (minor), little hazard to life

Reach 4: 2nd Mill Pond to Highway Culvert (200')

Again using Q=2000 from Computer Tabulation of Reach Capacity vs. Depth:

- Q=2000, D=9.4'

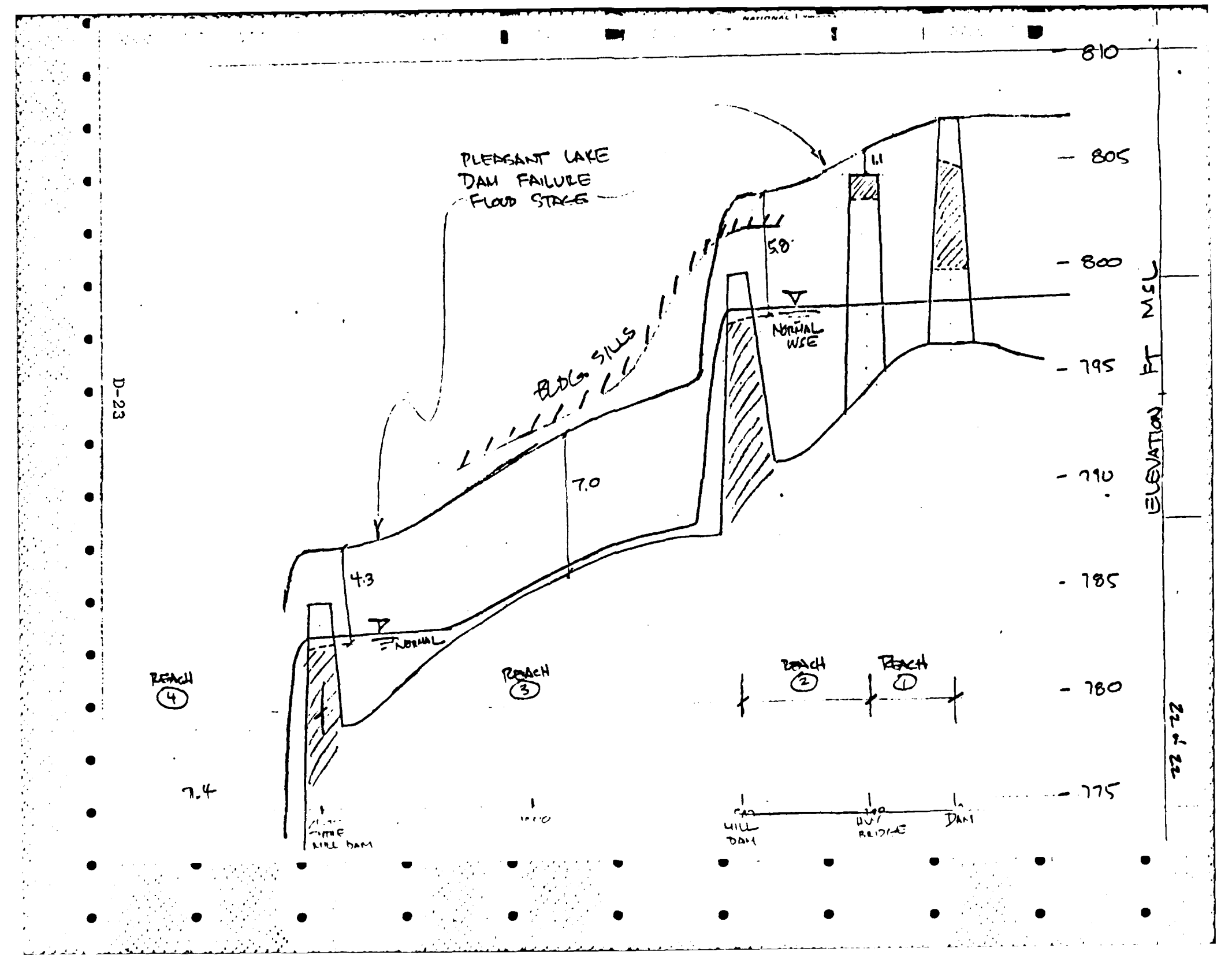
Only structure is highway culvert #16 (15'x5') Flow depth of 9.4' would overtop roadway which is about 7' above stream invert, possibly washing out culvert.

CALCULATIONS FOR FIRST DAM D/S OF PLEASANT LAKE

HEAD (feet)	DISCHARGE (cfs)			
	TOTAL	SPILLWAY	DAM CREST	SIDE SLOPES
795.00	0	0	0	0
795.50	15	15	0	0
796.00	42	42	0	0
796.50	76	76	0	0
797.00	118	118	0	0
797.50	165	165	0	0
798.00	250	216	33	1
798.50	425	273	144	9
799.00	660	333	298	29
799.50	947	397	485	65
800.00	1286	465	701	119
800.50	1673	537	942	195
801.00	2110	612	1205	294
801.50	2597	690	1489	418
802.00	3133	771	1792	569
802.50	3718	855	2114	750
803.00	4355	942	2453	960
803.50	5042	1032	2808	1203
804.00	5782	1124	3178	1479
804.50	6574	1219	3564	1791
805.00	7419	1316	3964	2138
805.50	8318	1416	4379	2523
806.00	9272	1519	4806	2947
806.50	10282	1623	5247	3411
807.00	11348	1730	5701	3917
807.50	12470	1840	6166	4464
808.00	13651	1951	6644	5056
808.50	14891	2065	7134	5692

CALCULATIONS FOR SECOND DAM D/S OF PLEASANT LAKE

HEAD (feet)	DISCHARGE (cfs) TOTAL	SPILLWAY	DAM CREST	SIDE SLOPES
782.60	0	0	0	0
783.10	35	35	0	0
783.60	100	100	0	0
784.10	184	184	0	0
784.60	283	283	0	0
785.10	478	395	74	9
785.60	779	519	210	49
786.10	1176	654	386	136
786.60	1673	799	594	280
787.10	2273	954	830	489
787.60	2980	1117	1091	772
788.10	3798	1289	1375	1134
788.60	4732	1468	1680	1584
789.10	5786	1656	2005	2126
789.60	6965	1850	2348	2767
790.10	8272	2052	2709	3511
790.60	9712	2260	3086	4365
791.10	11287	2476	3480	5332
791.60	13003	2697	3889	6417
792.10	14863	2925	4313	7625
792.60	16871	3159	4752	8960
793.10	19029	3399	5204	10426
793.60	21343	3645	5670	12028
794.10	23814	3896	6149	13769
794.60	26446	4153	6641	15652
795.10	29243	4415	7145	17683
795.60	32208	4683	7661	19864
796.10	35344	4955	8190	22199


PLEASANT LAKE
DAM FAILURE
FLOOD STAGE
BLDG SILLS
NORMAL WSE
NORMAL
5.8
1.1
7.0
4.3
7.4
REACH 4
REACH 3
REACH 2
REACH 1
LITTLE RIVER DAM
HILL DAM
HWY BRIDGE
DAM
810
805
800
795
790
785
780
775
ELEVATION, FT MSL
D-23

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY | MO | YR
NH	362	PLEASANT LAKE DAM	4325.2	7156.4	27NOV78

POPULAR NAME	NAME OF IMPOUNDMENT
	PLEASANT LAKE

RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
TR-BLACKWATER RIVER	ELKINS	0	300

YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE–FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
1950	RC	12	12	3000	1850	NED	N	N	N	N	13DEC78

REMARKS

MAXIMUM DISCHARGE (F.T.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
500												

ENGINEERING BY	CONSTRUCTION BY

REGULATORY AGENCY CONSTRUCTION	OPERATION	MAINTENANCE
NH WAT RES BD	NH WAT RES BD	NH WAT RES BD

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
[illegible] DENNICLIFF + ASSOC	20SEP78	PUBLIC LAW 92-367

REMARKS

END

FILMED

8-85

DTIC